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Comments are invited.

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# CONTENTS

## List of tables

## List of figures



## List of maps

# LIST OF ABBREVIATIONS

| | |
|---|---|
| ADD | Agricultural Development Divisions |
| AEZ | Agro-Ecological Zones |
| AGRA | Alliance for a Green Revolution in Africa |
| BMGF | Bill and Melinda Gates Foundation |
| CAPI | Computer Assisted Personal Interview |
| CDDS | Child dietary diversity score |
| CIP | International Potato Center |
| DARS | Department of Agricultural Research Services |
| DAES | Department of Agricultural Extension Services (Malawi) |
| DDS | Dietary diversity scores |
| DFID | Department for International Development (United Kingdom) |
| DNA | Deoxyribonucleic acid |
| DVM | Decentralized vine multipliers |
| EPA | Extension Planning Area |
| FANTA | Food and Nutrition Technical Assistance |
| FAO | Food and Agriculture Organization of the United Nations |
| GPS | Global positioning system |
| HDDS | Household dietary diversity score |
| HFIAS | Household food insecurity access scale |
| HKI | Helen Keller International |
| IA | Irish Aid |
| M&E | Monitoring & evaluation |
| MDD-W | Minimum Dietary Diversity – Woman |
| MK | Malawi Kwacha |
| NGO | Non-governmental organization |
| ODK | Open Data Kit |
| OFSP | Orange-Fleshed Sweetpotato |
| SP | Sweetpotato |
| USAID | United States Agency for International Development |
| USD | United States dollar |
| VAD | Vitamin A deficiency |

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# EXECUTIVE SUMMARY

***Motivation, objectives and methods***

In Malawi, a broad spectrum of research, development and funding agencies have supported the development and dissemination of biofortified, vitamin A rich orange-fleshed sweetpotato (OFSP) varieties since 2009. The objectives of these interventions are to increase OFSP production and consumption among populations at risk of Vitamin A Deficiency (VAD), with a focus on women of childbearing age and children under 5 in smallholder farm households. By 2019, 9 OFSP varieties have been released by Government of Malawi from the collaborative breeding program of the Malawi Department of Agricultural Research Services (DARS) and the International Potato Center (CIP). It is estimated that since 2009 some 500,000 households have received planting material of OFSP varieties through dissemination by CIP projects and implementing partners with a focus on increasing OFSP production, market development, and promoting its utilization for improved child and maternal nutrition.

This study presents results of a large-scale survey to assess adoption and utilization of OFSP varieties in Malawi. The study seeks to: i) understand how households access planting material and information about OFSP, ii) understand differences in adoption of OFSP varieties by project participants, non-participants and counterfactual households, iii) understand regional and varietal differences and preferences for adoption of sweetpotato varieties, iv) understand sweetpotato cultivation practices and yields, v) understand household OFSP utilization practices and effects of OFSP interventions on food and nutrition security, vi) assess availability and pricing of OFSP on the markets, and vii) assess the robustness of the survey results in terms of varietal identification, area measurements and yield estimations. An analysis of selected socio-economic and agronomic factors and their potential influence on adoption rates including expansion and substitution effects within local farming systems is presented.

The intended audience of this study are researchers, practitioners, donors and policy makers in Malawi and in other countries seeking useful information about adoption and food security outcomes of OFSP dissemination. The results and conclusions of the study are also relevant for donors and governments with the intention to further invest in OFSP research and development (R&D) programs, and to inform the appropriate design of future interventions to achieve their objectives more efficiently and effectively.

The study was conducted between February and August 2019. A survey using a stratified random sample of 2,492 households - representative of areas where OFSP dissemination had occurred at the national and regional levels - was conducted in all districts of Malawi stratified by project intervention levels and covering 1,421 project participants, 536 non-participants in the same intervention villages, and 535 counterfactuals in villages without project interventions. The survey included information about households' socio-economic condition and exposure to OFSP, adoption, production of OFSP and food security and nutrition. A survey was conducted in 41 markets across Malawi complemented with information about OFSP availability and commercialization. Additional data to help analyze and interpret the findings were collected through a variety of methods, including confirmation of genetic identity of

varieties through DNA fingerprinting (1,039 leaf samples from 388 household plots), plot area measurements (381 households), and sweetpotato yields based on crop cuts (579 fields).

Overall, about 75% of the respondents were from male-headed households of 45-46 years of age and had 5-6 years of schooling. In about 30% of the households there was a pregnant/breastfeeding woman. Average household size was 5.7 members and some 41% had a child under 5 years of age in household. About 18% of the households had participated in agricultural training activities and 21% on nutrition training activities. For 77% of the participant households, the main sources of OFSP vines were OFSP projects such as CIP implementing partners, or government officers. For 61% of non-participants, the main source of vines was other farmers within the same village. Farmers in the same village were the most important source of OFSP vines for the counterfactual group (56%).

***Results: adoption of OFSP varieties and land use, utilization, nutrition and commercialization***

A total of 90% of the total sample cultivated sweetpotato (including OFSP and other varieties) points to the importance of the crop for food security in Malawi. Results reveal the highest OFSP adoption rates (66%) for participating households that directly benefitted from an OFSP intervention. Non-participating households living in an intervention village indirectly benefitted from the intervention, with 46% of them also growing OFSP varieties in 2019. In comparison, counterfactual households had the lowest adoption rates (31%), as expected.

Adoption rates of OFSP were found to be significantly higher (58%) in the South than Central (51%) and North (49%) regions of the country because the introduction of these varieties started from the South followed by central then lastly north. The number of DVMs also follow the same pattern. Differences at district level are large within regions, with drought and flood-prone areas exhibiting higher adoption rates, suggesting that OFSP, in addition to its nutrition properties is a climate smart crop. This reflects that OFSP can be an important element of disaster response by emergency assistance programs from Government and relief agencies. The most widely adopted OFSP variety was Kadyaubwerere (13%), followed by Anaakwanire (7%) and Chipika (6%). Kenya, also known as Admarc, is the most widely planted non-OFSP variety (18%). The remaining households adopted other minor OFSP varieties. Planting of OFSP varieties by any household decreases several seasons after the last intervention, mainly due to reduced availability of planting material.

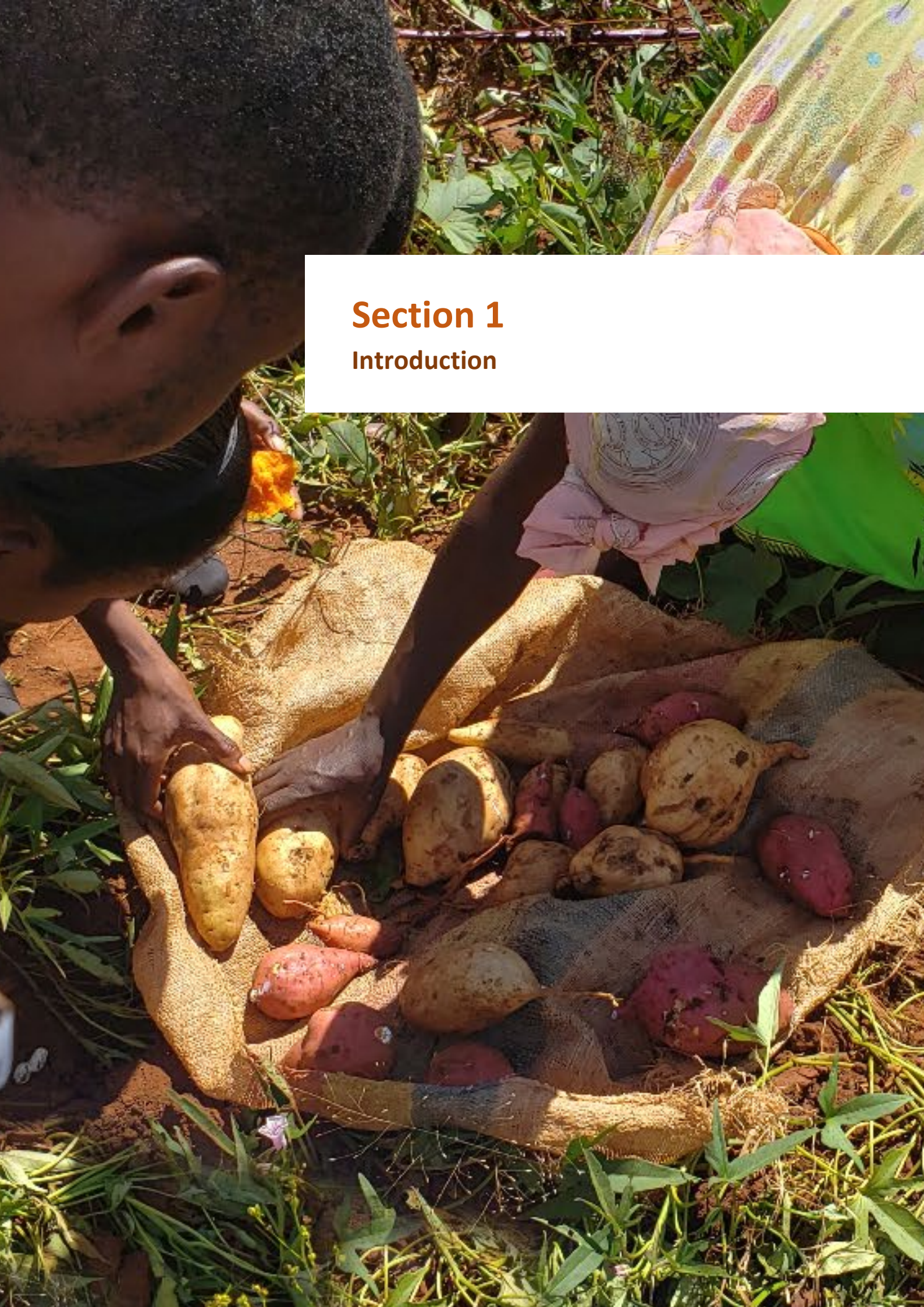
Sweetpotato is planted mostly in arable uplands, with about one-quarter of farmers growing sweetpotato in the *dambos* (shallow wetlands with highly fertile land) either to preserve vines or for off-season sweetpotato production. In general use of fertilizers, irrigation and pest protection chemicals is very low. Most farmers monocrop sweetpotato; only a small proportion of farmers intercrop sweetpotato with other crops (maize, cassava and pigeon pea). Overall average sweetpotato yield was 11.5 tons/ha, but with high variability. Yields estimated by crop-cuts in a smaller sample ranged from 8 tons/ha to 11 tons/ha, with significant variation among agroecological zones. Training on agronomy and access to better planting material increases yields for participants of OFSP interventions. Farmers planted little area to OFSP (0.08 acres) in the year of first planting. The OFSP area substantially increased in 2019 (0.31 acres). Areas in the North are smallest (0.07), followed by the Central (0.29) and Southern (0.38). Note that dissemination in the North began much later than in the South and Central regions. The main strategy to increase OFSP area is to replace other crops, notably maize.

Most OFSP projects also implemented nutrition education (e.g., through cooking demonstrations) and to some more intensive nutrition counseling, targeted at improving the quality of diets consumed by women caregivers and children under 5 years of age. Sweetpotato is consumed at least twice per week in harvest time by 78% of the households either as fresh roots, boiled or roasted. Child Dietary Diversity Scores (CDDS) in all categories of households were lower than the cutoff level of 4 food groups, but young children from participant households consumed higher number of food groups than counterfactual households. A similar result was found for women of reproductive age who did not meet the threshold requirement of five food groups for their group, although participants consumed, on average, higher number of food groups than caregivers in counterfactual households. Overall, the quality of diets consumed by young children and caregivers is higher in the Northern region compared to the Central region and to the poorer and shock-prone South region.

In addition to OFSP roots, dark green vegetables (pumpkin, amaranth and sweetpotato leaves) are a major plant-based source of vitamin A in the study communities. Both children (36.2%) and caregivers (42.4%) in the overall sample consumed OFSP roots at least once during the 7 days preceding the survey. No differences were found between categories of households or regions. Fish, consumed at least once a week, is the major animal-based source of vitamin A. Vitamin A consumption scores are higher for participant households compared to counterfactual households, and for the Northern and Central regions compared to the South.

OFSP was being sold in only 17 of the 41 markets. Kenya was the most important sweetpotato variety sold. Prices did not vary between OFSP and Kenya, and across the country, although the number of observations is too small to be conclusive. One-quarter of those selling OFSP were women, who fetched higher market prices than their male counterparts. On average, farmers earned revenues of MK 8,297 (approx. USD 12) per season from sweetpotato sales during the season, with no statistical difference by gender.

Confirmation of genetic identity by DNA fingerprinting showed that 42.5% of the samples collected in the field did not match any of the reference material, pointing to the rich sweetpotato diversity in Malawi. The most important varieties identified were Kaphulira, Kenya, and Kadyaubwerere, representing 12.7%, 11.1% and 9.8% of the total fingerprinted samples, respectively. Some varieties (Chipika, Anaakwanire, Mathuthu, Kenya) in the household survey are over-reported as the results of the DNA fingerprinting suggest. As a consequence, adoption rates of OFSP varieties are likely higher.



# Section 1

## Introduction

# INTRODUCTION

This section provides a background on the development and importance of orange-fleshed sweetpotato (OFSP) varieties in Malawi, and how OFSP has been disseminated across the country through various research and development projects. The main objectives and key research questions of the study are presented. After this a summary of the various methodologies used is presented and an outline of the report.

## 1.1 OFSP varieties and Vitamin A Deficiencies in Malawi

OFSP is considered an effective strategy to combat Vitamin A deficiency (VAD) in Africa (Low et al., 2017). In Malawi, a broad spectrum of research, development and funding agencies have supported the development and dissemination of OFSP varieties since 2009 to increase consumption of vitamin A among populations affected by VAD with a focus on women of childbearing age and children under 5 in smallholder farm households. Funding agencies included Irish Aid, United States Agency for International Development (USAID), Foreign and Commonwealth Development Office (FCDO), the Bill and Melinda Gates Foundation (BMGF), and Alliance for Green Revolution in Africa (AGRA) (Low and Thiele, 2020). More recently, the EU and GIZ have also started supporting OFSP as a component of large integrated CGIAR collaborative projects in the country. Through this support, CIP has been working with smallholder farmers, cooperatives, the Department of Agricultural Research Services (DARS), Districts Agricultural Development Offices, private sector, national and international NGOs, and universities to sustainably increase the productivity and production of sweetpotato systems for food and nutrition security and better, more resilient livelihoods for smallholder farmers. The Government of Malawi has included OFSP in the National Agricultural Investment Plan (NAIP, 2017-2023) and has directed the implementation of OFSP programs with International Potato Center (CIP) as their main research and development partner.

Recent data on VAD rates in Malawi reveal a sharp decline from 60% to 4% among children of preschool age between 2001 and 2016 (NSO, 2009 and 2016). Reasons for this decline include outcomes of different complementary health sector and nutrition strategies such as food fortification, Vitamin A supplementation, community-based nutrition outreach programs, and an increase in dietary diversity, including increased consumption of vitamin A rich foods such as OFSP. Costly Vitamin A supplementation programs, however, can only be scaled-back if cost-effective alternatives exist. Biofortification offers a clear pathway to achieve this but a better understanding is needed on what works, for whom, and for how long.

Between 2009 and 2019, OFSP varieties have been released by the Government of Malawi from the collaborative breeding program of the Malawi DARS and CIP (Table 1A in the appendix). Zondeni, a local OFSP landrace, was officially recommended in 2008 for release and promoted and disseminated by the Department of Agricultural Extension Services (DAES), CIP and NGO partners through a delivery project in 2009-2016 known as *Rooting Out Hunger*. In 2011, 5 new OFSP varieties (i.e., Anaakwanire, Mathuthu,

Kaphulira, Kadyaubwerere and Chipika), bred in Malawi, were released and included in DAES-CIP-NGO delivery projects across the country that began in 2014/15 and continued through 2019.[1] Three additional OFSP varieties were released in 2018 (Royal Choice, Msunga Banja and Mthesa Njala), although these were not yet being disseminated during the period covered in this study.

## 1.2 OFSP projects and beneficiaries in Malawi

Between 2009-2019, the six largest OFSP projects had jointly reached more than 300,000 direct beneficiary households who received at least 1 bundle of OFSP planting material (different available varieties) each. Including other OFSP interventions implemented by several NGOs in Malawi and the number of indirect beneficiaries reached by direct beneficiaries and by vine multipliers, our own estimations reveal that in total at least 500,000 households have received planting material of OFSP varieties.[2] The CIP interventions had different starting years; the earliest starting year was 2009. Two projects were still ongoing at the time of conducting this study (February-August 2019). While all regions were covered by OFSP interventions, the Southern region received most in terms of number of both OFSP interventions and direct beneficiaries, followed by the Central and then Northern region (Table 1).

Most OFSP projects had a common set of overall objectives focused on increasing OFSP production and promoting its utilization for improved child and maternal nutrition, although there was variation in the design and intensity of the nutrition intervention between projects. Once household level production was established, these projects also added a market development objective to support the expansion of production and contribute to household income. Within this common framework, the different projects emphasized different outcomes and learning objectives and accordingly devised different strategies and activities.

**Table 1.** OFSP Interventions - key descriptors

| No. | Project name | Start | End | Direct Benefic. (HH) | Region | Beneficiary lists availability | Donor |
|---|---|---|---|---|---|---|---|
| 1 | SUSTAIN I | 2014 | 2017 | 75,000 | North, Central, South | 2016 & 2017 | FCDO[1] |
| 2 | SUSTAIN II | 2018 | 2019 | 30,000 | North, Central | 2018 | FCDO[1] |
| 3 | MISST | 2015 | 2019 | 55,000 | Central, South | 2016 & 2017 | USAID |
| 4 | Rooting out Hunger | 2009 | 2016 | 106,000 | Central, South | 2010-2013 | Irish AID |
| 5 | DIVERSIFY | 2017 | 2020 | 3,000 | South | n/a | EU[2] |
| 6 | RTC-Action | 2016 | 2021 | 44,000 | South | 2016 | Irish AID |

Notes: [1]Foreign and Commonwealth Development Office (former DFID); [2] through United Purpose

[1] A catalogue listing these OFSP varieties with pictures and additional characteristics is published by Tumwegamire et al. (2014)

[2] The number of direct beneficiaries reported in project reports could be underestimated, as in some projects only beneficiaries for who quality M&E data sheets were submitted to CIP were officially counted. Some partners did disseminate vines but could not produce quality beneficiary sheets and therefore these beneficiaries were not officially reported to the donors. For example, in MISST project it is estimated that about 60-70% of actual number of farmers reached could be reported.

## 1.3 Objectives and research questions

The main objective of this study was to assess the adoption of OFSP varieties in Malawi after 10 years of OFSP dissemination activities at least 2 years after the intervention.

Other specific objectives were to

i) understand how households access planting material and information about OFSP;

ii) understand differences in adoption by project participants, non-participants and counterfactual households[3]; non-participants resided in project villages but did not participate in OFSP project; counterfactual households lived in villages without any OFSP intervention and thus did not participate in OFSP project;

iii) understand regional and varietal differences and preferences for adoption of sweetpotato varieties;

iv) understand sweetpotato cultivation practices and yields;

v) understand household OFSP utilization practices and effects of OFSP interventions on food and nutrition security;

vi) assess availability and pricing of OFSP on the markets;

vii) assess the robustness of the survey results in terms of varietal identification, area measurements and yield estimations.

To achieve these objectives, the study addressed the following research questions:

1. What project interventions have the households been exposed to and how have they accessed planting materials?
2. What is the extent of adoption of OFSP at project intervention level?
   **a)** What is the share of households growing OFSP versus non-OFSP in project intervention areas?
   **b)** To what extent did OFSP spill over to non-participants and counterfactual households?
3. Are there any regional and varietal differences in OFSP adoption?
4. Is there a difference in sweetpotato yield between project participants, non-participants and counterfactual households?
5. What type of land is allocated to sweetpotato and what are the common production practices?
6. Have there been any changes in land area under different sweetpotato varieties?
7. What crops or varieties are being substituted by OFSP?
8. Do participants of an integrated agriculture-nutrition project have better access to food and a higher intake of micronutrient-rich and quality diets?
   **a)** What are the differences in food access among participant, non-participant and counterfactual households?

3

**b)** What are the differences in the frequency of intake of Vitamin A-rich foods by women and young children in participant, non-participant and counterfactual households?

**c)** What are the differences in diet diversity of women and young children in participant, non-participant and counterfactual households?

9. What are the OFSP revenues and sales for OFSP producing households?
   **a)** Is OFSP present in major markets in Malawi during the harvest time? And what is the relation between the intervention and presence of roots in the market?
   **b)** Is there price differential between OFSP and other sweetpotato varieties in these markets?
10. What is the extent of varietal (mis)identification of planted sweetpotato varieties in the 2019 cropping season by contrasting farmers' reports and DNA fingerprinting?
    **a)** Are there any regional differences regarding (mis)identification of sweetpotato varieties and does that differ between OFSP and non-OFSP types?
    **b)** Are there any differences between intervention groups?
11. How do yield and area estimations based on recall data in the survey compare to actual measurements and crop cuts in the field?

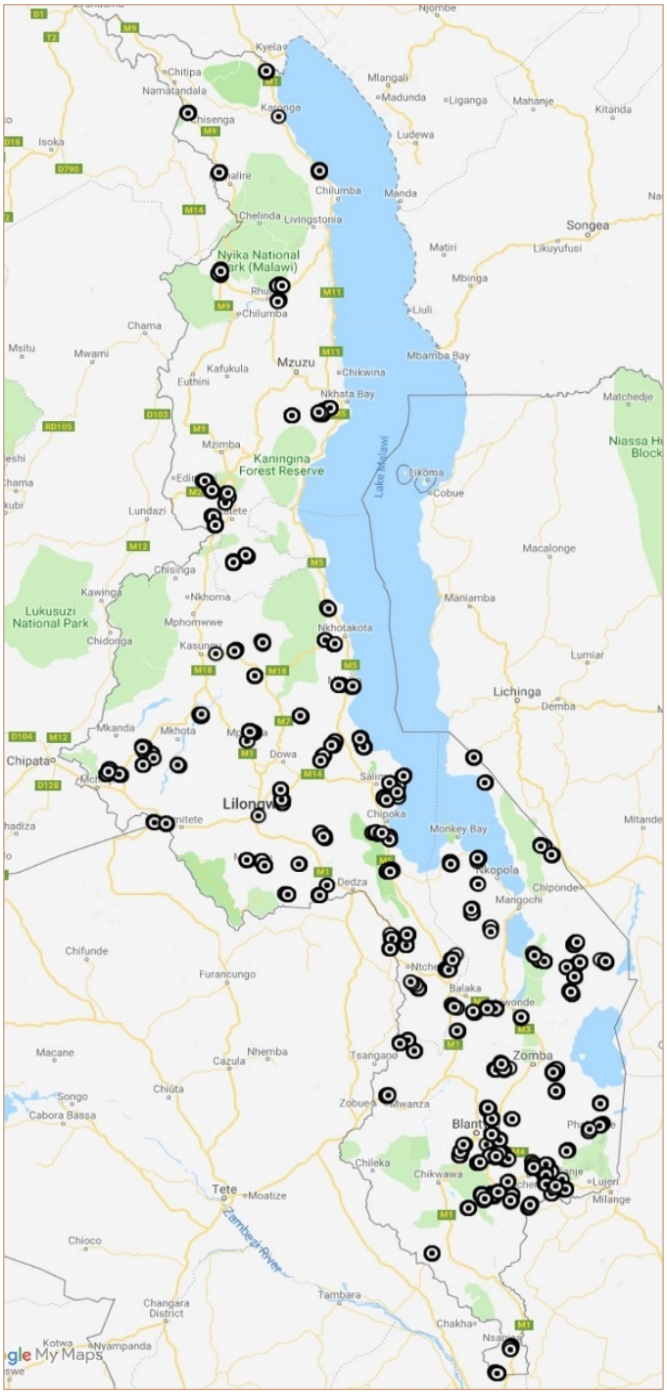
## 1.4 Purpose of this report

This report aims to present the background, objectives and methodologies used in the OFSP adoption study in Malawi and the results of descriptive analysis of the main research findings. The data that form the basis for this report will be used for more in-depth analyses on determinants and impacts of adoption of OFSP, to be published separately in scientific journals. Therefore, discussion on the determinants of outcome variables, especially of project-related aspects, present important insights for more rigorous analysis but can in this report only be treated as indicative.

## 1.5 Summary of methodology and outline of this report

The study was conducted between February and August 2019. It comprised an initial phase of design (February to May 2020) with key stakeholders followed by of a combination of surveys and field measurements (May to July 2020). A large, country representative household survey was conducted in all districts of Malawi (Map 1) with 2,492 households. The sample comprised project participants, non-participants in the same intervention villages, and counterfactuals in villages without project interventions. The participant sample was selected from three recent projects: SUSTAIN 1, MISST and RTC-Action. A detailed methodology of the household survey design and sampling procedure is presented in Section 2 (Survey Design). Data from this survey formed the basis of Section 3 (Socio-economic factors and exposure to OFSP), 4 (Adoption), 5 (Cultivation Practices, Yields, and Land-area/use Changes) and 6 (Utilization and Nutrition). Section 7 (Commercialization and Revenues) presents the methods and results of an OFSP market survey that was conducted in 41 markets across Malawi. Section 8 (Robustness Validation of Key Variables) presents methods and results of different study activities that complement the household survey and provide important data to verify and/or help to interpret the findings in the adoption study. These robustness activities include (1) a varietal identification exercise based on the analysis of 1,039 sweetpotato leaf samples collected from 388 household plots, (2) plot area

measurements in the fields of 381 households, and (3) yield assessment of sweetpotato based on crop cuts conducted on 579 fields. The crop cut was the only exercise which was conducted separately and prior to the household survey (March to May 2020). A short village survey (results not presented) was administered to a group of key informants in each of the 166 sampled villages to inform and validate described data. In Section 9, we present selected major findings and conclusions.




**Map 1.** Sample distribution

# Section 2

## Survey Design

# SURVEY DESIGN

## 2.1 Research design

The primary objective of this study was to analyze adoption of OFSP, with a particular focus on varieties introduced and disseminated through targeted agriculture and nutrition projects between 2009 and 2017. The research design is aligned to achieve this primary objective. An important aspect of our research design is that the sample is stratified by project intervention levels. Stratification was firstly applied to distinguish between intervention and non-intervention areas. Within intervention areas, we further stratified between project participants and non-participants. This resulted in three groups: (1) project participants, (2) non-participants, and (3) counterfactual, where (1) and (2) lived in the same village where a project was implemented and (3) are households that lived in villages without any OFSP project or intervention. Separating out these three groups allowed us to analyze the extent to which OFSP varieties reached households beyond project participants – also called direct beneficiaries – and remoter areas not targeted by OFSP projects or interventions. As a secondary purpose, the stratification allowed us to analyze the effectiveness of specific project-related activities on OFSP adoption on key outcome variables (see below), especially comparing (1) to (3). Group (3) served as counterfactual, which allowed us to analyze a scenario of outcome variable changes if no project/intervention was delivered.

## 2.2 Selection of OFSP interventions and their key elements

Selection of OFSP interventions was done as follows. First, vine distribution must have been completed no later than 2017. This allowed for an analysis post OFSP intervention which is desirable in order to analyze adoption and other outcomes after projects end. Since data collection was completed in 2019 and the cut-off point for vine distribution was set to the year 2017, any analysis is hence conducted for at least 2 years post intervention. Second, projects were selected which all had the same OFSP varieties availability for distribution. This is important as it keeps gains from genetic improvement constant and any observed outcome differences are due to other factors.

From the total of six OFSP projects, for this study, three projects were selected - SUSTAIN 1, MISST, and RTC-Action (see Table 1 for project key descriptors). Monitoring and Evaluation (M&E) data limitations restricted the sampling of implementation years to 2016 and 2017. Overall, the available M&E for these projects and implementation years were used to sample participants and was critical for the overall sampling design (e.g., selection of intervention village). The scaling activities in these projects were implemented by over 40 partners including District Agricultural Development Offices, national and international NGOs and USAID contractors and their implementing partners. These partners were implementing a range of projects with different objectives in which OFSP could be adopted. The objective for including OFSP could be improving nutrition, income generation, enhancing resilience or a combination of these. Depending on the project objectives, these partners worked with care groups (to enhance nutrition), farmers groups or associations, youth clubs, women groups, vulnerable communities,

school feeding programs, or other extension methods. CIP developed a Mother Baby Trial (MBT) approach that could be adopted by all these partners and projects.

This approach aimed to demonstrate varietal performance and recommended agronomic practices while at the same time disseminating messages on the nutritional benefits of OFSP. A typical Mother-baby trial consisted of one 'mother site' where six OFSP varieties are planted in six plots by a group of 50 (in MISST and SUSTAIN projects) or 100 (in RTC-Action project) farmers. Partners were instructed to select households with a pregnant or breastfeeding mother or at least one child under the age of five, a requirement that was easily adopted by partners implementing nutrition programs but proved more challenging for partner implementing agricultural productivity programs. Each of the farmers received one bundle to plant in their own field as a 'baby plot'. The farmer groups gathered throughout the season and at harvest at the mother site for hands-on trainings. The mother and baby plots were also a means to multiply the initial bundles of distributed vines with the aim to reach more farmers beyond project participants. The elements and activities of selected OFSP interventions included the distribution of planting material, farmer agronomic training, nutrition education, marketing and demand creation activities (Table 2). Note that project participants were not all exposed to all project activities equally. While an integrated agriculture-nutrition-marketing approach was preferred, the actual components depended on the resources and specific objectives of the implementing or collaborating partner organization. For instance, only a share of farmers received nutrition counseling, mainly, due to its costly nature of implementation as recipients receive in-depth one-on-one weekly counselling over a period of time. Implementing partners who implemented the MBT approach through their already established 'care group systems' in ongoing nutrition programs, could easily incorporate OFSP messaging and recipe demonstration in nutrition counseling. On the other hand, partners that implemented productivity, value chain and environmental programs would usually not engage farmers in extensive nutrition counseling and recipe demonstrations. However, all partners were trained by CIP in the nutritional benefits of OFSP and how to conduct sensory evaluations at harvest time of the MBTs. Messages about the benefits of OFSP in terms of Vitamin A were therefore normally included as part of the mother-baby trial activities at planting time, mid-season and during harvest when all 50-100 'baby farmers' would gather at the 'mother plots' for joint learning.

***Table 2.*** *OFSP project elements activities of selected interventions*

| *Project activity* | SUSTAIN I | MISST | RTC-Action |
|---|---|---|---|
| Vine dissemination | X | X | X |
| Mother-baby trials | X | X | X |
| Agronomic training | X | X | X |
| Nutrition counselling | x | | X |
| Nutritional sensitization: radio | X | X | X |
| Nutritional sensitization: flyer | X | X | X |
| Demand creation: drama, theater, songs | | X | |
| Demand creation: cooking & recipes | X | | X |
| Demand creation: media | | X | X |
| Post-harvest training: grading/sorting | X | X | X |

| | | | |
|---|---|---|---|
| Post-harvest training: packaging | | | X |
| Post-harvest training: transportation capacity | | | X |
| Post-harvest training: triple S | | | X |
| Market linkages: fresh roots | X | X | X |
| Market linkages: processing | | | X |

In addition, the research design needed to be flexible enough to address the various research questions identified. The key outcome variables of this study were: (a) adoption of OFSP and (b) intake of OFSP, with (a) measured at the varietal and household level, and (b) measured at the household level. In studying these, analyzing the effectiveness of project activities on outcome variables was an important, yet secondary, aspect of the study. For this study, the adoption of OFSP in the most recent cropping season at the time of the survey is refer to. For the majority of the sample, this was the rainfed season in 2019. For some respondents the most recent season was winter of 2018. This study defines the adoption in 2019 as OFSP cultivation in rainfed season of 2019 or winter season of 2018, but at least 2 years after the intervention.

## 2.3 Sample size calculation

To determine the sample size needed to address the research questions, a power calculation was conducted. Important for the power calculation was to get an understanding of the key outcome variables of the study region. We realized, however, that information on all outcome variables was not readily available; availability was limited to a few districts of Malawi and to other countries (see for example Sindi et al., 2013 and de Brauw et al., 2018). In the absence of reliable nationally representative data, the study relied on expert knowledge to estimate level of adoption for the purpose of sample size calculation.

We estimated that about 500,000 households have been reached through CIP and partner interventions distributing OFSP vines and we assume that the majority of these have, at some point, planted OFSP. Given a total population of about 15 million people in Malawi and assuming an average household size of 5 household members, totaling 3 million households, an adoption rate of about 17% was arrived at %. Adoption data at the varietal level is lacking. Therefore, a proxy varietal-level OFSP adoption rates by an assumed national-level 17% adoption rate for OFSP. In using this estimate, the minimum sample size for a simple random sample would be 602 households to estimate adoption of OFSP with a statistical power of 95% and 3% level of precision.[4]

To allow for clustering at the village level, further sampling adjustments are required. In doing so, prior studies suggest that an appropriate intra-cluster correlation for rural households in Malawi is close to 0.3 (Handa et al., 2018; Ragasa and Niu, 2017). Our own calculations reveal expected costs of USD 2,015 for each additional sampled village, and USD 46 for each additional sampled household (see Appendix 1 for detailed theoretical framework used for power calculation; see Table 2A for parameters used and outcomes of power calculation; see Table 3A for household-level costs estimation breakdown; see Table 4A for village-level costs estimation breakdown). Using all these parameters for the power calculation,

[4] The power calculation is robust to using different parameters (i.e., 18.4 million (population), 4.4 (average household size)) resulting in a lower assumed adoption rate.

the minimum sample size is 2,409 households. The available funds for this research allowed us to increase the total sample size to 2,520 households.

## 2.4 Sampling proportional to size

At the highest administrative level, the region, an equal allocation of the total sample across all districts would have resulted in about 840 households each. However, sweetpotato area and production in Malawi are distributed unequally across the regions. Estimates for the production season 2014-2015 reveal that about 11% of sweetpotato area can be found in the Northern region, 37% in the Central region, and 52% in the Southern region (National Agricultural Production Statistics, 2016). The lower area in the North reflects the distribution of population in the country: just 13% of Malawi's population resides in the Northern region, compared to 42% in the Center and 44% in the South (National Statistics Bureau, 2018). The highest population density is in the South (244 persons/sq km), followed by the Center (211 persons/sq km); then the North (84 persons/sq km).

**Table 3.** SP area, beneficiaries and sample by intervention group and region

| | SP area (2014-15) | SP area | Project benef.[a] | Project benef. | Total sample | Leaf sample[b] |
|---|---|---|---|---|---|---|
| *Region* | **(ha)** | **(%)** | **(#)** | **(%)** | **(# HH)** | **(# HH)** |
| North | 27,041 | 11 | 3,871 | 9 | 285 | 52 |
| Central | 87,361 | 37 | 15,179 | 37 | 900 | 188 |
| South | 122,988 | 52 | 22,132 | 54 | 1,335 | 284 |
| ***Total*** | ***237,390*** | ***100*** | ***41,182*** | ***100*** | ***2,520*** | ***524*** |

**Notes:** Likoma district excluded; for logistical purposes, number of households are sampled only in increments of 15 households and a minimum of 15 households per village. In some districts the number of households were brought down to a round number which can be divided by 15; in other cases, households were brought up; for sampled non-participants, generally 1/3 of total sample are considered. A detailed version of this table by district can be found in the Appendix (Table 5A). [a] These numbers are based on the available M&E data. [b] Leaf sample refers to the households whose fields were sampled for sweetpotato leaf sample collection. SP = Sweetpotato; benef. = beneficiary.

To account for these cultivation patterns, we sampled households within districts proportionate to the relative sweetpotato production area of that district: a higher sample was drawn from districts with higher sweetpotato production. In addition to sweetpotato area, the intensity of project intervention has also been different across Malawi. To account for this, the sampling was done proportionally to project intensity. Thus, more households were drawn from districts with overall relatively higher numbers of project beneficiaries. By chance, it was found that an almost complete overlap between Sweetpotato (SP) area (%) and project beneficiaries/intensity (%) across regions (Table 3). Thus, sampling households based on sweetpotato production areas allowed us to sample by project intensity at the same time. No additional weighting was required to account for project intensity.

## 2.5 Sampling design and actual sample

All 27 districts were sampled, except for Likoma island. This means that our sample is nationally representative of Malawi. At the next lower administrative level – the extension planning area (or EPA) – we randomly selected EPAs within each district. Two different EPA lists were established: one list was for

intervention EPAs, i.e., with OFSP project/intervention, and another list for counterfactual villages, i.e., without any OFSP project/intervention. To validate intervention and non-intervention EPAs, a workshop was organized in April 2019. Workshop participants included all major CIP-partners and government extension agents who had knowledge of past and current OFSP dissemination activities. At the next administrative level – the section – we randomly drew from section lists. For non-intervention sections, validation of results was done during the workshop by contacting officials of the randomly selected sections. And in case where it was found that OFSP vines were disseminated in a section, that section was replaced with another one, until it was found that it was a section without intervention. The same sampling procedure was followed at the village-level: based on complete village lists, villages were randomly drawn and reconfirmed OFSP (non-)intervention by contacting section and village officials.

For logistical purposes, 15 households per village were sampled. Within each intervention village, 11 households (participants) were randomly selected from the beneficiary list. Four additional households were selected from a different list of households which did not benefit from a project directly (non-participants). In villages without intervention/treatment, 15 counterfactual households were randomly selected from established household lists. Non-participants and counterfactual households were only selected if these had cultivated any type of sweetpotato in winter season of 2018 or rainfed season of 2019.

***Actual sample***

Data for 2,492 households was collected, in 166 villages across 27 districts in Malawi making our study representative at the national and regional (i.e., north, central, south) level (see Map 1). 28 households from the initial sample of 2,520 households did not participate in the interviews for various reasons: funerals, absence, household could not be identified. Data collection took place between June and July 2019, during the sweetpotato harvest period. A total of 18 enumerators, divided into three teams of 5 enumerators and 1 team leader, collected data in 3 villages per day. The maximum number of households to be interviewed per village was 15 which means that 5 enumerators interviewed 3 households per day. The interviews lasted about 1.5 hours and were conducted using tablet-based questionnaires (see Supplementary Material A). Prior to data collection, a two-week intensive enumerator training including two days of piloting, ensured that all enumerators were knowledgeable about the questionnaire, skilled in using tablets, and trained in conducting surveys under field conditions. The piloting phase also allowed us to revise the tools and adapt the questions and interview process to fit the local context.

At the household level, standardized sampling procedures were used for household selection. Generally, one day prior to data collection, another support team would visit the sampled village for household sampling. Visiting one day prior to data collection turned out to save considerable time, because sampling did not have to happen on the same day as data collection and allowed us to adequately inform officials at various levels about our research activities further, ensuring that selected household heads were available for interviews when the team visited. In counterfactual villages, household lists were established jointly with village chiefs and other officials from which we randomly selected households.

Following the household classification mentioned earlier resulted in sampling 1,421 participants, 536 non-participants, and 535 counterfactual households. Data checks, however, revealed that 10 (~150 households) of the 36 counterfactual villages actually received an OFSP intervention. It was discovered only after data collection. This 'contamination' of the counterfactual group may affect the adoption and

other outcome results. As this contamination was only identified after substantial parts of the analysis and documentation thereof was already completed, we refrain from presenting updated tables and figures in this paper. Instead, however, verification checks were conducted for all key results which were found to be robust to a reclassification of the households that were incorrectly specified as counterfactuals. If reclassification resulted in differences, in significance levels across groups or regions, then this was indicated in the text.

## 2.6 Ethics clearance and informed consent

For this study, we received ethical clearance from the National Commission for Science & Technology in Malawi. The ethics clearance letter can be found in the Supplementary Materials (Supplementary Material – B). Furthermore, an informed consent was prepared and read out to each respondent before the interview. The informed consent can be found in the beginning of the questionnaire instrument (Supplementary Material – A). Participation in the interviews was voluntary and respondents did not receive any monetary or in-kind compensation for their time.

# Section 3

## Socio-economic Factors and Exposure to OFSP

# SOCIO-ECONOMIC FACTORS AND EXPOSURE TO OFSP

## 3.1 Household characteristics

Table 4 presents selected summary statistics of the respondents of the household survey. Overall, about 77% of the respondents were from male-headed households. Some 75% of respondents were married living with the spouse and the average respondent was 46 years of age. Respondents had, on average, 5.6 years of schooling which is relatively little and confirmed by other studies for Malawi (Ambler et al., 2018). Differences in schooling could be one important determinant of technology adoption and farming practices (Appau et al., 2019). Results further show that the average household had 5.6 members. 32% of households had an infant in the household, 43% a child under 5 years of age, 12% a disabled person, and 28% a pregnant or breastfeeding woman.

**Table 4.** Summary statistics of household survey respondents

| | Total | Male-headed HH | Female-headed HH | Participant | Non-participant | Counter-factual |
|---|---|---|---|---|---|---|
| | *(N=2,492)* | *(N=1,928)* | *(N=564)* | *(N=1,421)* | *(N=536)* | *(N=535)* |
| *Variables* | Mean | Mean | Mean | Mean | Mean | Mean |
| % male household head | 77 | 1 | 0 | 76 | 79 | 78 |
| Age (years) | 46 | 44[a] | 48 | 46 | 45 | 45 |
| % married, living with spouse | 75 | 94[a] | 0.08 | 74 | 78 | 76 |
| Years of schooling | 5.9 | 6.5[a] | 4.01 | 6.0[b] | 5.9 | 5.6 |
| % literacy | 76 | 82[a] | 56 | 77[b] | 77[c] | 72 |
| Household size | 5.6 | 5.8[a] | 4.9 | 5.6 | 5.6 | 5.6 |
| % HH with pregnant/breastf. woman | 28 | 31[a] | 22 | 25[b] | 33 | 31 |
| % HH with child under 5 years | 40 | 43[a] | 32 | 39 | 43 | 40 |
| % HH with disabled person | 12 | 12 | 14 | 12 | 12 | 12 |
| % HH with infants | 30 | 32[a] | 22 | 28 | 33[c] | 30 |

**Note**: [a,b,c] significant different at 1-10%-level compared to female-headed HH or counterfactual group, respectively.

Male-headed and female-headed households are statistically different regarding almost all variables. Female-headed households are, on average, 4 years older, not married (but divorced/separated (42%) or widow (36%); this is confirmed also by having on average 1 household member less), had 1.5 years less of schooling and only 56% were literate. Possibly, due to absence of a husband, female-headed households were less often comprised of infants, children under 5 years of age, or pregnant/breastfeeding woman. Overall, these statistics suggest that female-headed households were more vulnerable than male-headed households. Regarding the household group categories, we only find a few statistical differences. Participants, for example, had 0.4 years more of education, had 6% points higher literacy rate and the incidence of having a pregnant/breastfeeding woman was 6% lower compared to counterfactual group.

## 3.2 Description of project activities

Table 5 summarizes findings regarding exposure to project activities. Survey results revealed that about 18% of our sample (N=2,492) participated in project-related agricultural training activities during implementation. If the respondent did so, (s)he attended on average 1.75 sessions. For nutrition training, 21% of respondents participated with an average of 2.14 sessions attended. As expected, project participants partly received agricultural (27%) and nutrition training (26%).

**Table 5.** Project OFSP activity exposure by intervention group

| | Total | | Participant (1) | | Non-participant (2) | | Counterfactual (3) | |
|---|---|---|---|---|---|---|---|---|
| *Project activity* | Obs. | Mean | Obs. | Mean | Obs. | Mean | Obs. | Mean |
| *Training* | | | | | | | | |
| Agriculture | 2,492 | 0.18 | 1,421 | 0.27[a,b] | 536 | 0.08 | 535 | 0.03 |
| Agriculture (#) | 440 | 1.75 | 381 | 1.77[a] | 42 | 1.55[c] | 17 | 1.77 |
| Nutrition | 2,492 | 0.21 | 1,421 | 0.26[a,b] | 536 | 0.13 | 535 | 0.13 |
| Nutrition (#) | 513 | 2.14 | 376 | 2.22[a,b] | 69 | 1.77[c] | 68 | 2.09 |
| *Radio program* | | | | | | | | |
| OFSP radio | 2,492 | 0.43 | 1,421 | 0.45[a,b] | 536 | 0.41[c] | 535 | 0.38 |
| OFSP radio (#) | 1,067 | 2.66 | 644 | 2.62[b] | 222 | 2.57[c] | 201 | 2.86 |
| OFSP radio liked | 1,067 | 0.97 | 644 | 0.97 | 222 | 0.98 | 201 | 0.95 |
| *Flyer, skit, song, cooking demo, recipes[z]* | | | | | | | | |
| OFSP flyer received | 1,956 | 0.07 | 1,399 | 0.09[a] | 336 | 0.02 | 221 | 0 |
| OFSP flyer received (#) | 129 | 1.19 | 121 | 1.19 | 8 | 1 | 0 | |
| Skit/drama participation | 1,956 | 0.05 | 1,399 | 0.06[a,b] | 8 | 0.02 | 221 | 0.02 |
| OFSP song listened to | 1,956 | 0.21 | 1,399 | 0.22[b] | 336 | 0.19[c] | 221 | 0.16 |
| Cooking demonstration | 1,956 | 0.26 | 1,399 | 0.31[a,b] | 336 | 0.17[c] | 221 | 0.10 |
| Recipes received | 1,878 | 0.17 | 1,365 | 0.21[a,b] | 315 | 0.09 | 198 | 0.05 |

**Notes**: [a] significance at least at 10%-level between groups (1) and (2); [b] significance at least at 10%-level between groups (1) and (3); [c] significance at least at 10%-level between groups (2) and (3). [z] only for respondents with stated OFSP adoption.

A radio program featuring OFSP nutrition messaging some 43% of the total sample listened to at least once. Slightly but significantly more project participants (45%) listened to radio program compared to non-participant group (41%) and counterfactual group (38%). As radio programs can be listened to over far-distances without projects/interventions to be physically present the results are reasonable and, in addition, constitutes a cost-effective project activity. If respondents listened to the OFSP program, they did so on average 2.6 times. Interestingly, respondents in counterfactual villages listened on average significantly more to radio programs compared to participant and non-participant groups. Overall, 97% of respondents enjoyed listening to the radio programs with information about OFSP.

Other project activities were also important. If respondents cultivated OFSP at some point in time, 26% participated in a cooking demonstration, 21% listened to OFSP songs at least once, 17% received OFSP recipes, 7% received OFSP flyer, and 5% participated in skits or dramas at some point. Clearly, exposure

was highest for participants, followed by non-participants, and then counterfactual respondents. Yet, OFSP songs were at least listened to once by 16% of counterfactual respondents compared with 22% and 19% of participants and non-participants. Probably, songs were played on the radio which were broadcasted countrywide, such as in MISST project where a famous Malawian musician (Skeffa Chimoto) composed an OFSP song which was widely promoted and broadcasted on radio.

## 3.3 Sources and recipients of OFSP planting material

Our findings point at differences regarding sources of OFSP planting material by intervention group. As predicted, participants' main source of OFSP vines were from CIP and/or implementation partners, or government officers (77%) (Table 6). Compared to vines sourcing irrespective of time, vine sourcing during the peak of OFSP interventions (post 2016/2017) from OFSP projects, CIP-partners, and government is higher (90% for participants). Sourcing vines from farmers within the same village is particularly the case for non-participants (61%; 58% after 2016). Living in the same villages as participants, this finding suggests that non-participants benefited from spillovers. Non-participants generally planted one season after participants, meaning that benefits also became available with a lag of one season. The observed 18% share of non-participants sourcing from OFSP project or government officials likely refers to exactly that time lag of one season when vines from the initial batch of promoted OFSP planting material was multiplied for further dissemination within the village a season later.

For the counterfactual group, farmers in the same village are the most important source of OFSP vines (56%). However, the relatively high share of farmers sourcing vines from farmers in another village (18%) suggests that the identified OFSP varieties promoted through OFSP projects after 2016 arrived in counterfactual villages through this type of cross-village interactions. In counterfactual villages, especially government officers are also important sources of planting material (16%).

**Table 6.** Vine sources of first-time OFSP adopters

| | Total | | | First time planting (after 2016/17) | | |
|---|---|---|---|---|---|---|
| | Participant | Non-participant | Counter-factual | Participant | Non-participant | Counter-factual |
| | *(N=1,421)* | *(N=536)* | *(N=535)* | *(N=1,421)* | *(N=536)* | *(N=535)* |
| *Vines source* | (%) | (%) | (%) | (%) | (%) | (%) |
| Farmer same village | 15 | 61 | 56 | 4 | 58 | 40 |
| Farmer another village | 3 | 11 | 18 | 1 | 9 | 18 |
| CIP/partner/government | 77 | 18 | 11 | 90 | 21 | 16 |
| Market | 1 | 4 | 8 | 0 | 5 | 10 |
| Commercial farmer | 0 | 3 | 3 | 0 | 3 | 7 |
| Other | 4 | 3 | 5 | 5 | 3 | 10 |

After the first cropping season, in 34% of the cases OFSP vines were shared with one of intervention target groups as shown in Table 7. Among these, 15% of the vines were shared with women with a child <5 years of age, 11% of vines with breastfeeding women, and 8% with pregnant women. In 30% of the cases, OFSP vines were shared with other women, which means that in total 64% of the shared vines were received by women. In 33% of the cases, men were the recipients of OFSP vines.

**Table 7.** Recipient groups of OFSP vines by type and intervention group

| | Total | Participant | Non-participant | Counter-factual |
|---|---|---|---|---|
| | | *(N=1,421)* | *(N=536)* | *(N=535)* |
| | (%) | (%) | (%) | (%) |
| *Recipient type* | | (1) | (2) | (3) |
| CIP-project target groups | 34 | 35 | 31 | 34 |
| Woman with child <5 years | 15 | 15 | 14 | 17 |
| Pregnant woman | 8 | 8 | 7 | 8 |
| Breastfeeding woman | 11 | 11 | 9 | 9 |
| Other woman | 30 | 31 | 30 | 25 |
| Other man | 33 | 32 | 38 | 36 |
| Other (disabled person, youth) | 3 | 3 | 2 | 4 |
| All women (combined) | 64 | 66[a,b] | 61 | 59 |

**Notes**: [a,b] significant at the 1-5% level comparing (1)-(2) and (1)-(3), respectively.

Overall, the results suggest that an active sharing culture of sweetpotato planting material exists after projects end or in the absence of a project. Sharing is particularly high among women, but men are also important recipients of vines. This informal sharing culture suggests that more formal market transactions are nascent.

# Section 4

## Adoption

# ADOPTION

## 4.1 OFSP adoption

In 2019, 54% of total sample cultivated an OFSP variety (Table 8). Clear differences exist for intervention groups. First, project participation resulted in sustained adoption rates of 66% 2-3 years post intervention. In contrast, only 27% of counterfactual households that lived in a non-treatment village cultivated an OFSP variety in 2019. The project-related demand and supply creating mechanisms are likely important determinants, among many other demographic, socio-economic, and institutional factors. Secondly, it was found that there were significant project-related spillover effects. Some 48% of households that did not participate in an OFSP intervention but lived in a treatment village cultivated OFSP in 2019. Also, here, adoption rates were significantly higher compared with counterfactual group. Project-related elements, such as better access to vine multipliers, or indirect exposure to training, are likely at play. A further in-depth analysis on the determinants of adoption is warranted.

**Table 8.** Sweetpotato and OFSP adoption rates post intervention by intervention group

| | Total Sample | Participant | | Non-participant | | Counter-factual | |
|---|---|---|---|---|---|---|---|
| | *(N=2,492)* | *(N=1,421)* | | *(N=536)* | | *(N=535)* | |
| *Variables* | (%) | Obs. | (%) | Obs. | (%) | Obs. | (%) |
| *Adoption in 2019*[t] | | | | | | | |
| OFSP | 54 | 932 | 66[a,b] | 258 | 48[c] | 164 | 31 |
| Sweetpotato | 90 | 1,210 | 85[a,b] | 506 | 94[d] | 517 | 97 |

**Notes**: [t] adoption in rainfed season of 2019 or winter season of 2018; [a,b,c] significant difference between groups at 1%-level; [d] significant difference between groups at 5%-level. OFSP=orange-fleshed sweetpotato.

Regarding sweetpotato in general, which includes also OFSP, it was found that 90% of the total sample cultivated at least one sweetpotato variety in 2019. In addition, there are significant differences among household categories. For sweetpotato, adoption rates for non-participants and counterfactual households were significantly higher (94 and 97%, respectively) compared with participants (85%). This might suggest that many participants were first-time (orange-fleshed) sweetpotato adopters who did/could not fall back on other non-OFSP varieties. This is supported by our finding that first-time sweetpotato adoption was, on average, 2 years later for participants compared with counterfactual group[5]. In contrast, sweetpotato adoption in counterfactual villages was being sustained through functioning informal seed systems.

[5] Participants mean year of first-time sweetpotato adoption was 2006 and for counterfactual group 2004. The difference was significant at P<0.000.

## 4.2 Adoption by project intervention

Overall, OFSP adoption rates in 2019 were in the range of 62-69% across projects, as shown in Table 9. The RTC-Action project had the highest share of OFSP adopters (69%), followed by MISST project (67%), and SUSTAIN project (62%). Both MISST and RTC had statistically higher adoption rates by participants than SUSTAIN participants because these projects were in these areas for a longer period. Various project-related activities may have contributed to the observed OFSP adoption differences between projects. OFSP interventions generally provided demand- and supply creating mechanisms. On the demand side, nutrition and agricultural training was provided and radio programs created, whereas the supply side consisted, for example, of establishing decentralized vine multipliers (DVMs). Important to note is that SUSTAIN 1 relied on a single, large-scale vine multiplier whereas MISST and RTC-Action used multiple smaller-scale DVMs. Another important difference was the nutrition counseling activity which was only implemented by RTC-Action. This may have had an effect on stimulating adoption by changing nutrition behavior. In contrast, MISST and SUSTAIN projects focused on extensive nutrition messaging and cooking demonstrations.

**Table 9.** OFSP adopters (in 2019) by project intervention and group

| | | Total | | Participant | | Non-participant | |
|---|---|---|---|---|---|---|---|
| | | *(N=1,957)* | | *(N=1,421)* | | *(N=536)* | |
| *Group* | | Obs. | (%) | Obs. | (%) | Obs. | (%) |
| MISST | (1) | 763 | 63[a,b] | 562 | 67[b] | 201 | 54[a,b] |
| RTC-Action | (2) | 503 | 62[c] | 356 | 69[c] | 146 | 45 |
| SUSTAIN | (3) | 692 | 57 | 503 | 62 | 189 | 44 |

**Note**: [a,b,c] significant difference at the 1-5% level; [a] significant difference between (1)-(2); [b] significant difference between (1)-(3); [c] significant difference between (2)-(3).

MISST project had the significantly highest share of non-participant OFSP adopters (54%), followed by RTC-Action (45%), and SUSTAIN (44%). Possibly, demand-creating project activities may be at play. For instance, MISST project organized theaters and produced songs jointly with villagers. All villagers, not just participants, were exposed to these activities (i.e., performing a play, singing/broadcasting songs). A study conducted by CIP in Nigeria found that songs that highlight the benefits of OFSP increases its demand (Lagerkvist et al 2018)

In addition, however, many other factors may be at play affecting the observed differences in adoption rates. For example, access to planting material 2-3 years post intervention is one important factor which, in turn, may be regionally dependent. Regions with overall higher OFSP project intensity over the years likely have produced more sources for planting material (e.g., decentralized vine multipliers, progressive farmers) increasing access to and availability of quality OFSP planting material. SUSTAIN project, for example, invested less in training and establishment of decentralized vine multipliers compared to MISST and RTC Action projects.

## 4.3 Adoption by region

Table 10 presents the adoption rate by region. The rates were significantly higher (58%) in the South than Central (51%) and the North (49%). This finding is in line with our prediction that the South would reveal higher adoption rates because OFSP interventions have been more intense here. Also note that other OFSP interventions focused on the South. More intense intervention efforts are generally associated with better access and availability of planting material and the development of a critical mass further stimulating demand for OFSP material. This may have also had an effect on adoption rates for participants which are the highest in the South (70%) and significantly different from adoption rates in Central (61%) and North (61%). In line with this finding, adoption rates for non-participants are also highest in South (51%) which, however, is significantly different from the observed adoption rate in the North (41%) but not for the Central (46%). Interestingly, it was found that there is an inverse relationship between OFSP adoption and intervention intensity for the counterfactual group. This suggests that projects were more effective in creating spillover effects or that households, by default and for unknown reasons, have better access to OFSP varieties.

**Table 10.** OFSP adopters (in 2019) by intervention and group

| | | Total | | Participant | | Non-participant | | Counter-factual | |
|---|---|---|---|---|---|---|---|---|---|
| | | *(N=2,492)* | | *(N=1,421)* | | *(N=536)* | | *(N=535)* | |
| *Region* | | Obs. | (%) | Obs. | (%) | Obs. | (%) | Obs. | (%) |
| North | (1) | 284 | 49[a] | 142 | 61[a] | 51 | 41[a] | 91 | 34 |
| Central | (2) | 949 | 51[c] | 551 | 61[c] | 203 | 46 | 195 | 30 |
| South | (3) | 1259 | 58 | 728 | 70 | 282 | 51 | 249 | 30 |

**Note**: [a] significant difference at 1-10%-level between (1)-(3); [c] significant difference at 1-10%-level between (2)-(3).

However, regional differences exist at district level, as depicted in Table 7A in the appendix. For instance, adoption rates across districts in the North vary between 36%-69% for participants, 0%-55% for non-participants, and 20%-47% for the counterfactual group. Even in the South where most of OFSP interventions occurred, adoption rates range between 51%-91% for participants, 23%-64% for non-participants, and 0%-67% for the counterfactual group. A closer look reveals that Nsanje and Chikwawa, the most southern districts of Malawi and typical flood-prone areas, exhibit higher adoption rates (75% and 90%, respectively) than the regional average (70%). It is especially noteworthy that the Southern Region is often affected by drought and floods and receives emergency assistance form Government and relief agencies. Distribution of OFSP planting material has become an important element of disaster response by Government World Food Program and FAO in particular.

## 4.4 Adoption of OFSP at varietal level

Table 11 shows adoption rates at the varietal level. Kadyaubwerere was the most widely adopted OFSP variety in 2019. Of the total of 2,186 planted varieties, Kadyaubwerere's share was 13%, Anaakwanire ranks second with a share of 7% and Chipika with 6%. Across all regions, Kadyaubwerere was the most widely planted variety, especially popular in the north where it held a share of 34%. An explanation is that relatively more participant households received Kadyaubwere. In the North and Central regions, other OFSP varieties were only planted marginally. In contrast, in the South Anaakwanire (9%) and Chipika (8%)

were planted to a considerable extent.[6] Kadyaubwerere is also by far the most widely adopted variety among participants and similarly popular among non-participants. Possibly, the comparatively faster multiplication rates of Kadyaubwerere than the other 2011 OFSP releases resulted in easily increased availability of planting material of this variety beyond initial distributions. In terms of non-OFSP varieties, Kenya remained the most widely planted sweetpotato variety, which was of particular importance in the north. Interestingly, it was also widely planted among participants and even at higher rates compared with the counterfactual group.

## 4.5 Varietal adoption rates comparing 2019 with pre-2019

Table 12 compares adoption rates between varieties adopted pre-2019 and 2019. All promoted OFSP varieties were still cultivated post intervention. For many farmers the last moment of dissemination was several seasons ago. Except for varieties Kadyaubwerere and Kaphulira, for which it was observed that increasing adoption rates, all other OFSP varieties have experienced a reduction in adoption rates. Notably, Kamchiputu's difference between 2019 and pre-2019 (4%) is the most considerable among all OFSP varieties. In contrast, for all key non-OFSP varieties it was observed that there were increasing shares of adoption comparing pre-2019 with 2019 adoption rates. Most strikingly, Kenya increased its share by 4.5%. This could be a result of a decreased share observed for many OFSP varieties in 2019.

**Table 11.** Varietal adoption in last planting season (in 2019) by region and intervention group

| | Total | Region | | | Intervention Group | | |
|---|---|---|---|---|---|---|---|
| | | North | Central | South | Part. | Non-part. | Counter-factual |
| | *(N=2,186)* | *(N=188)* | *(N=820)* | *(N=1,178)* | *(N=1,487)* | *(N=404)* | *N=(295)* |
| *OFSP variety* | (%) | (%) | (%) | (%) | (%) | (%) | (%) |
| Kadyaubwerere | 13 | 34 | 13 | 10 | 17 | 8 | 2 |
| Anaakwanire | 7 | 4 | 6 | 9 | 9 | 4 | 2 |
| Chipika | 6 | 1 | 4 | 8 | 7 | 4 | 1 |
| Kaphulira | 5 | 2 | 6 | 5 | 6 | 4 | 2 |
| Kenya[a] | 5 | 5 | 6 | 4 | 4 | 5 | 8 |
| Mathuthu | 4 | 5 | 4 | 4 | 5 | 2 | 0 |
| Zondeni | 4 | 2 | 3 | 4 | 4 | 4 | 0 |
| Mugamba[a] | 3 | 1 | 4 | 3 | 3 | 5 | 3 |
| Kamchiputu | 3 | 0 | 6 | 1 | 3 | 3 | 3 |
| John | 2 | 3 | 2 | 2 | 1 | 3 | 4 |
| Other OFSP | 47 | 45 | 46 | 48 | 39 | 57 | 73 |
| *Yellow/cream* | *(N=4,011)* | *(N=566)* | *(N=1,583)* | *(N=1,862)* | *(N=2,052)* | *(N=943)* | *(N=1,016)* |
| *Kenya* | 18 | 25 | 15 | 18 | 19 | 18 | 16 |
| *Mugamba* | 7 | 4 | 8 | 7 | 8 | 8 | 5 |
| *Other yellow/cream* | 75 | 71 | 77 | 75 | 73 | 74 | 80 |

**Notes**: Adoption rates presented at the varietal level. Total number of OFSP varieties adopted in 2019 (or winter 2018) were N=2,186 and for yellow/cream varieties N=4,011; [a] variety Kenya and Mugamba are listed because they were mis-identified by respondents as orange-fleshed.

[6] To support learning of variety names, all bundles of planting material were labeled with the respective name of the variety

## 4.6 Reasons for not planting certain sweetpotato varieties in 2019

As has become evident, respondents disadopted varieties of all flesh color and across household categories. Here, we discuss various reasons (Table 13). By far, access to/availability of planting material was the main reason for not planting certain types of sweetpotato during the last two seasons, irrespective of color. Breaking the findings down by color reveals that access to and availability of planting material was the main reason 45% of the respondents did not plant OFSP varieties, 37% yellow-fleshed varieties and 27% white/cream varieties. The second major reason for not planting certain types of sweetpotato during the last 2 seasons was traits/characteristic of the variety. Other factors including late maturity, susceptibility to pest and diseases, drought resistance, low root yield also contributed to the decision to not plant certain varieties of sweetpotato.

**Table 12.** Varietal-level adoption rates pre-2019 and in 2019

| | Pre-2019 | 2019 | Difference |
|---|---|---|---|
| *Variety* | (%) | (%) | (%) |
| *OFSP variety* | | | |
| Kadyaubwerere | 6.24 | 6.41 | 0.17 |
| Kamchiputu | 5.83 | 1.79 | -4.04 |
| Anaakwanire | 5.00 | 3.84 | -1.16 |
| Chipika | 3.71 | 2.81 | -0.9 |
| John | 3.49 | 2.62 | -0.87 |
| Zondeni | 2.68 | 1.87 | -0.81 |
| Mathuthu | 2.66 | 2.54 | -0.12 |
| Kaphulira | 2.21 | 2.89 | 0.68 |
| *Non-OFSP varieties* | | | |
| Kenya | 9.65 | 14.1 | 4.45 |
| Mugamba | 3.77 | 5.72 | 1.95 |
| Babache | 1.83 | 1.91 | 0.08 |
| Other | 52.93 | 53.5 | 0.57 |

**Table 13.** Respondents main reasons for not planting in 2019 by sweetpotato flesh color

| | Total | OFSP | Yellow | White/cream |
|---|---|---|---|---|
| | *(N=3,645)*[z] | *(N=1,326)* | *(N=989)* | *(N=1,134)* |
| | (%) | (%) | (%) | (%) |
| *Respondent reason* | | (1) | (2) | (3) |
| Varietal traits/characteristics | 23 | 17[a,b] | 23[c] | 29 |
| Access/availability of planting material | 37 | 45[a,b] | 37[c] | 27 |
| Resource constraints | 7 | 6[a] | 9 | 7 |
| Farmer's choice/other reasons | 14 | 8[a,b] | 16[c] | 22 |
| Beyond farmer's control | 13 | 18[a,b] | 11 | 9 |
| Other | 5 | 5 | 5 | 5 |

**Notes**: [z] N= total number of adoptions at varietal level cultivated in 2019. This number exceeds total sample size (N=2,492) because some households reported to cultivate more than 1 variety in 2019; [a,b,c] significant at the 1%-level. [a] compares (1)-(2); [b] compares (1)-(3); [c] compares (2)-(3); detailed table depicting all reasons can be found in Table 8A in the appendix.

# Section 5

## Cultivation Practices, Yields, and Land-area/use Changes

# CULTIVATION PRACTICES, YIELDS, AND LAND-AREA/USE CHANGES

This section presents results of sweetpotato: (1) cultivation practices, including land-use, (2) yields based on survey recall, and (3) land-area/use changes, including effects on other crops. In discussing land-area changes, Kenya variety is used as benchmark of one of Malawi's most dominant varieties. Despite its dominance, it is a yellow-fleshed variety, very low in beta-carotene content[7] compared to its orange-fleshed counterparts. For the yields part of this section, details on data collection and calculation are presented to better understand the challenges of using OFSP recall data.

## 5.1 Cultivation practices: land types

Most of the respondents planted sweetpotato in arable lands with about one-quarter growing sweetpotato in the *dambos* during the most recent season preceding the survey (Table 14). *Dambos* – shallow wetlands with highly fertile land – are commonly used for crop production during the off-season when it is dry because they usually are high in residual moisture.

In some parts of the southern region (Chikhwawa and Nsanje), the dry season is the main season for sweetpotato production especially in the lowlands which flood during the rainy season. Overall, a very small proportion (less than 10%) of the respondents cultivated sweetpotato on marginal lands (e.g., hillsides, roadsides and public land). The study found no differences in land use practices among the different categories of households.

**Table 14.** Type of land in which sweetpotato is typically grown by variety and land type

| | Sample size[8] | Arable land | Dambo/low land | Land on hill side | Road side/Road reserve | Prohibited area from the river/lake |
|---|---|---|---|---|---|---|
| *Variety* | | (%) | (%) | (%) | (%) | (%) |
| Zondeni | 179 | 71.3 | 20.8 | 3.2 | 3.2 | 1.4 |
| Anaakwanire | 350 | 70.3 | 23.2 | 4.0 | 1.9 | 0.7 |
| Kaphulira | 203 | 67.2 | 27.7 | 2.7 | 2.0 | 0.4 |
| Mathuthu | 205 | 66.5 | 25.7 | 3.9 | 0.4 | 0.0 |
| Kadyaubwerere | 537 | 62.0 | 29.9 | 3.9 | 3.9 | 0.1 |
| Chipika | 251 | 70.2 | 24.1 | 3.7 | 2.0 | 0.0 |
| Kenya | 1,067 | 62.5 | 27.5 | 5.0 | 3.6 | 1.1 |
| Mugamba | 407 | 68.6 | 23.3 | 3.6 | 2.6 | 1.8 |
| Kamchiputu | 322 | 67.3 | 25.4 | 5.1 | 1.7 | 0.5 |
| John | 267 | 65.1 | 25.5 | 5.9 | 2.9 | 0.3 |
| Other OFSP | 143 | 65.4 | 26.2 | 4.1 | 3.1 | 1.0 |

[7] Yellow-flesh types have other carotenoids contributing to color than beta-carotene. The beta-carotene content of Kenya is only 2.02 mg/100 gms. In contrast, orange-fleshed Kadyabwerere has 20.15 mg/100 gms.

[8] Recall data based on the most recent season preceding the survey.

## 5.2 Cultivation practices: inputs and intercropping

Results show that slightly more than 90% of all respondents planted their last crop of any type of sweetpotato during the rainfed season of 2019 which ran from December 2018 to April/May 2019. The rest (9.8%) planted their last crop of sweetpotato during the winter/dry season of 2018, that is, between June/July to November/December 2018. The results further show that 68% of the plots were in the uplands. Overall, farmers, regardless of intervention group, travelled nearly 30 minutes, on average, to reach their plots (Table 4). This finding reflects the nature of settlements in Malawi where homesteads were, in most cases, clustered together. The results show that there were large variations in the time travelled to the plot, which could be due to wide range of factors including the topography, availability of agricultural land and road network.

In terms of sweetpotato management practices, the proportion of farmers applying improved production practices – notably fertilizers, irrigation and pest protection chemicals – was quite low (Figure 1). Generally, Malawian farmers hesitate to apply fertilizer because they believe that it has negative effects on the taste of the sweetpotato roots, and they prefer instead to allocate expensive inputs to other crops such as maize or tobacco. The low usage of these yield-enhancing inputs, especially pesticides, in Malawi is in line with findings from other studies (e.g., Torkelsson & Onditi, 2018). Further, a small proportion (13%) of the study respondents intercropped sweetpotato with other crops.

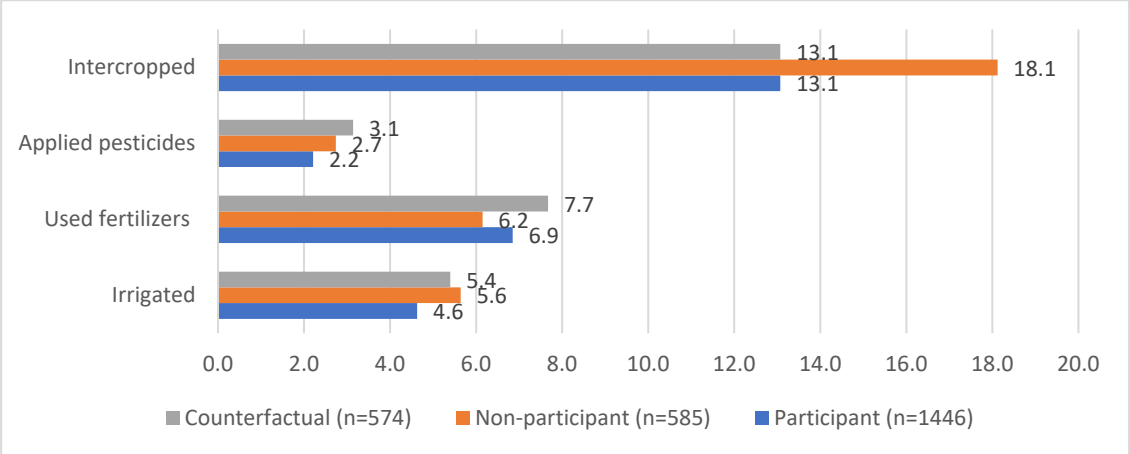



**Figure 1.** Sweetpotato cultivation practices by intervention group

The main crops used in the sweetpotato intercrop were maize, cassava and pigeon pea (Table 15). Apart from pigeon pea, the other legumes used in the intercrop were beans, peas and cowpeas. However, very small proportions (about 3%) of farmers used these legumes as intercrops.

**Table 15.** Main crops intercropped with sweetpotato

| | Plots with intercrop |
|---|---|
| | *(N=370)* |
| *Crop* | (%) |
| Maize | 28.1 |
| Cassava | 22.2 |
| Pigeon pea | 10.0 |
| Tomato | 6.0 |
| Other | 33.7 |

## 5.3 Yield estimates based on survey recall

Sweetpotato is usually harvested piecemeal and utilized as needed. This makes collecting accurate data on total harvest through recall at the end of the season quite challenging. At the same time, farmers typically have difficulties estimating the size of the land they cultivate. This is major problem especially where plots are of irregular shape and/or small in sizes. To overcome the first challenge, the study team used a method that traces both major (i.e., one-off) and minor (the piecemeal type) harvests for each plot throughout the season. This method minimizes the recall bias/challenges in piecemeal situations by focusing the respondents to think of a typical week during the season, and a typical harvest during that week, and approximating harvest throughout the season based on that week.

This section presents yield estimates for sweetpotato in general and for sweetpotato in plots that had at least one variety of OFSP in it. Because of the common practice of mixing varieties, the data collected does not allow us to calculate yield estimates for specific OFSP varieties. The variety-specific yield estimates for OFSP varieties was therefore based on data collected under the crop-cut component of the study. Crop-cut results and comparison with recall data yield results can be found in Section 8.

Table 16 presents the average and median yield of sweetpotato, in general, among the three household categories based on farmer recall. The average and median yield for the entire/combined sample is 11.5 and 6.66 tons/ha, respectively, with participant households obtaining higher, but also more variable, average yields than the counterfactual households. The Sidak pairwise test of difference in average yields across the three household categories indicate that yields obtained by the participant households are, on average, significantly higher (p-value=0.012) than those of counterfactual households. Similar tests, however, find no difference in mean yields between the participants and non-participant households living in the same intervention villages. The reported mean yields are well within range predicted by past studies in Malawi and other SSA countries (Low et al, 2017; van Vugt and Franke, 2018). These studies report actual mean yields ranging between 5 tons/ha to 25tons/ha. This high variability in yields is reflected in our high standard deviations.

**Table 16.** Average root yield of sweetpotato among study households by intervention group

| | Total | Participant | Non-participant | Counter-factual | p-value |
|---|---|---|---|---|---|
| Yield (t/ha) | *(N=2,492)* | *(N=1,184)* | *(N=478)* | *(N=507)* | |
| Mean | 11.47 | 12.04[a] | 11.39[ab] | 10.20[b] | 0.012 |
| Median | 6.66 | 7.15 | 6.23 | 5.83 | |
| Standard deviations | 11.75 | 12.08 | 11.79 | 10.82 | |

**Notes**: [a,b] denote statistical difference based on Sidak pairwise test of difference in means between household categories.

OFSP yield in the plots that contained OFSP are presented in Figure 2 below along with that of Kenya variety for the whole sample and by household category. The yield of Kenya is presented for comparison. The yield for OFSP plots was higher for participant households (12 tons/ha) than non-participant and counterfactual households. The Sidak multiple comparison test found statistically significant difference (p-value=0.010) between the household categories. However, the yield of OFSP was in all cases lower than what the study households across the three categories obtained for variety Kenya. The difference was especially much larger for counterfactual households perhaps because these households did not receive training on OFSP agronomy as did the participant households and were located very far from intervention communities.

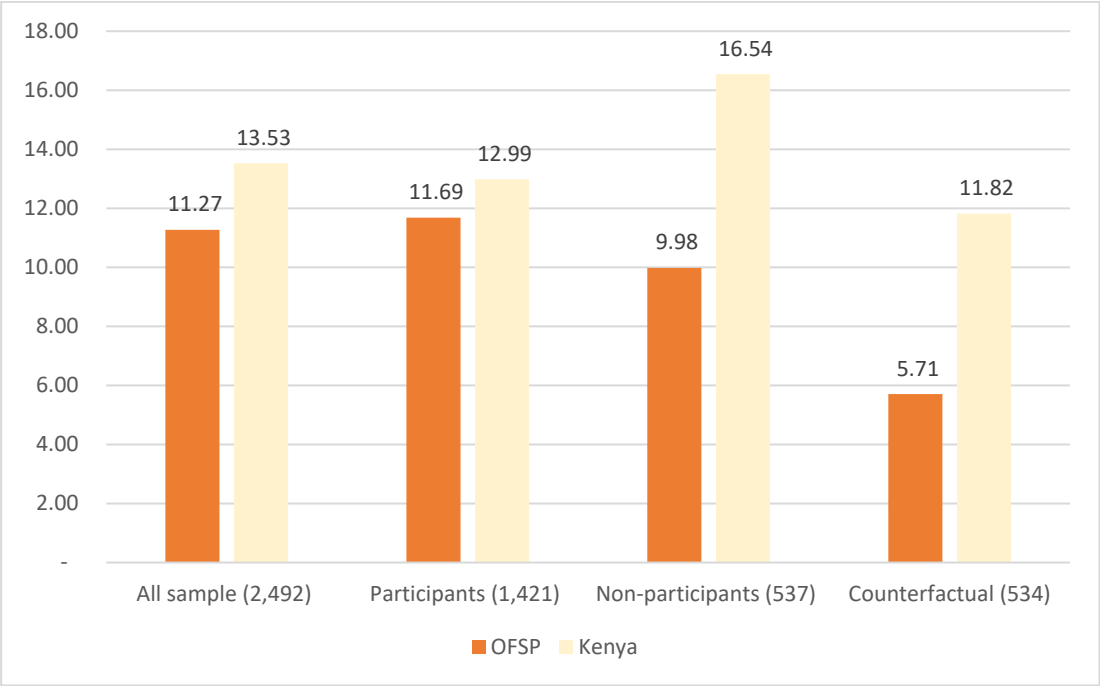



**Figure 2.** Yield (tons/ha) of OFSP and Kenya varieties by intervention group

## 5.4 Land-area changes of sweetpotato varieties

Farmers were asked about the area they planted in the first year they planted an OFSP variety. The area planted to the first OFSP variety averaged 0.10 acres (Table 17). The size of the plots confirms that first time OFSP production is mainly done at a small scale, usually in-home gardens. This is because farmers usually receive a small quantity of vines as a starter material. Interestingly, in the central and southern regions, areas planted to first OFSP variety were significantly larger than in the north.

Participants had significantly smaller (0.08 acres) OFSP area compared to non-participants (0.11 acres) and counterfactual groups (0.14 acres). In intervention areas, the disseminated OFSP vines (e.g., 1-2 bundles) were only sufficient to cover small areas, frequently used in home gardens. In cases of spontaneous adoption, the first-time planting of OFSP is done on much larger areas, possibly because more planting material was available from other farmers who planted in earlier years and multiplied the material.

Based on the crop-cut exercise[9], it was found that OFSP area averaged 0.31 acres in 2019 for participants only. Land area in 2019 was much larger compared with area planted to first OFSP variety for participants (0.08 acres). This suggests that participants have increased land area planted to OFSP after having received only small quantity of vines during project implementation. There were clear and significant differences across regions: in the North the lowest OFSP area (0.07 acres) was found, followed by the central (0.29 acres) and southern (0.38 acres) parts. More intense project support in central and southern parts may contribute to these differences.

**Table 17.** Area planted to first OFSP variety and in 2019 based on recall data by region and intervention group

| | Total | North | Central | South | Part. | Non-part. | Counter-factual |
|---|---|---|---|---|---|---|---|
| | *(N=1,913)* | *(N=203)* | *(N=735)* | *(N=975)* | *(N=1,362)* | *(N=329)* | *(N=222)* |
| | Mean | Mean | Mean | Mean | Mean | Mean | Mean |
| *First planted OFSP* | | (1) | (2) | (3) | (1) | (2) | (3) |
| Area (acre) | 0.10 | 0.06[a,b] | 0.08[c] | 0.11 | 0.08[a,b] | 0.11[c] | 0.14 |
| | | | | | | | |
| *OFSP in 2019[d]* | *(N=579)* | *(N=58)* | *(N=235)* | *(N=286)* | | | |
| Area (acre)[e] | 0.31 | 0.07 | 0.29 | 0.38 | | | |

**Notes**: 1 outlier excluded (25 acres); [a,b,c] significant at the 1-10%-level; [a] compares (1)-(2); [b] compares (1)-(3); [c] compares (2)-(3). [d] based on crop-cuts for project participants only. [e] Results are significantly different at the 1%-level using a Bartlett's test for equal variances. Part. = Participant.

Since the year of first OFSP planting, it was found that for the total sample the OFSP area has increased in 36% of the cases (Table 18). This confirms the results for OFSP area increases based on crop-cut. In contrast, in 39% of the cases, OFSP area had decreased or remained unchanged in 11% of the cases (Table 18). The high share of farmers reporting decline in OFSP area may be explained by dis-adoption of older OFSP varieties, such as John or Kamchiputu (in exchange for new OFSP varieties). Likewise, insufficient access to planting material may be another reason.

In the North and Central parts of Malawi, the percentage of farmers that reported an increase in area under OFSP cultivation was lower than the percentage reporting a decrease. Only in the South, was a higher percentage increases area planted to OFSP (38%) compared to the percentage of farmers decreasing OFSP area (30%). For the South, this suggests that a substantial share of farmers is willing to adopt and/or expand OFSP production. Project intensity, which was highest in the South, may also have contributed to this.

Furthermore, share of participants and non-participants increased OFSP more (36% and 37%, respectively) compared to counterfactual households (30%). Likely, access to OFSP vines was for many participants and non-participants relatively higher than counterfactual village due to project support. What is striking is that a higher share of participants and counterfactual households decreased OFSP area than increased OFSP area. For participants, this may be a result, again, of insufficient access to planting material. Only a higher share of non-participants increased rather than decreased OFSP.

[9] The study relied on crop-cut results, because the household survey data for OFSP area is likely subject to measurement error. For instance, in many instances we found varietal mixtures which limits the clear distinction of flesh-color.

**Table 18.** Land area changes of OFSP in 2019 compared with year first planted

| | Total | North | Central | South | Part. | Non-part. | Counter-factual |
|---|---|---|---|---|---|---|---|
| | *(N=1,915)* | *(N=203)* | *(N=736)* | *(N=976)* | *(N=1,362)* | *(N=331)* | *(N=222)* |
| *Area…* | *(%)* | *(%)* | *(%)* | *(%)* | *(%)* | *(%)* | *(%)* |
| Increased | 36 | 39 | 32 | 38 | 36 | 37 | 31 |
| Decreased | 39 | 47 | 48 | 30 | 39 | 32 | 45 |
| Stayed same | 11 | 5 | 6 | 16 | 9 | 13 | 16 |
| After 2016[z] | 15 | 9 | 15 | 16 | 15 | 18 | 9 |

**Notes**: [z] cultivation started after 2016; outlier excluded (>25 acres).

## 5.5 Land area changes for variety Kenya

Area planted to Kenya decreased according to 48% of respondents (Table 19); yet 30% of farmers who cultivated Kenya in 2019 increased the area during the last 3 years. Kenya is losing importance especially in northern and central regions where more than 50% of respondents decreased the area planted to it. This happened to a lesser extent in the southern region where 34% of farmers reported to leave the area unchanged. Kenya is appreciated as being very early maturing and having good root and leaf taste.

**Table 19.** Share of respondents stated land area changes of variety Kenya in 2019 compared with 3 years ago

| | Total | North | Central | South | Part. | Non-part. | Counter-factual |
|---|---|---|---|---|---|---|---|
| | *(N=1,606)* | *(N=378)* | *(N=614)* | *(N=614)* | *(N=971)* | *(N=311)* | *(N=324)* |
| *Area…* | (%) | (%) | (%) | (%) | (%) | (%) | (%) |
| Increased | 30 | 35 | 30 | 29 | 31 | 29 | 30 |
| Decreased | 48 | 56 | 55 | 37 | 49 | 50 | 50 |
| Stayed same | 21 | 9 | 15 | 34 | 20 | 22 | 20 |
| After 2016[a] | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Notes**: [a] cultivation started after 2016; unit of analysis is the variety.

Across intervention groups, the proportional shares are very similar. The study predicted that land that participants planted to Kenya would have decreased more than in the other two groups because of the dissemination of OFSP varieties. Yet, Kenya was equally losing importance in the non-participants and counterfactual groups.

## 5.6 OFSP expansion and effects on other crops

Figure 3 shows the various expansion pathways, in case farmers decided to expand their OFSP cultivation. Generally, expansion happened by substituting other crops. In 35% of the cases, expansion happened at the expense of area planted to other non-OFSP varieties. Strikingly, reduction in area planted to maize, one of Malawi's most important food crops, was reported in 31% of the cases. Other crops substituted were cassava (7%), groundnuts (7%), pigeon peas (6%), soybean (3%), and beans (2%). This finding suggests that the main strategy to increase OFSP area is to replace area under other crops (66% of cases).

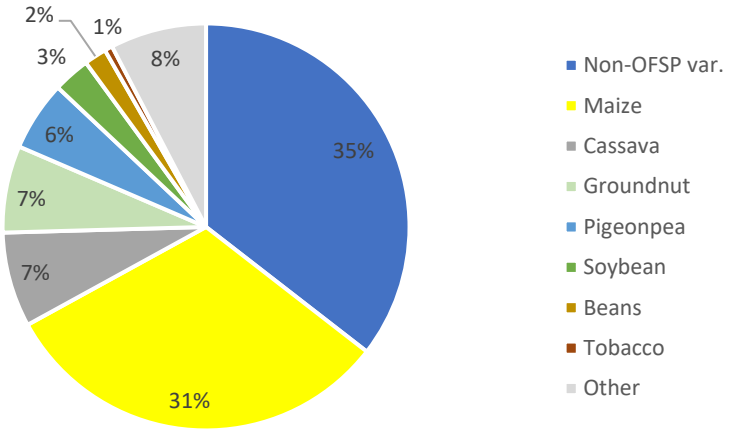



**Figure 3.** Share of respondents (in %) reduced area under other non-OFSP varieties and crops due to OFSP area expansion

# Section 6

## Utilization and Nutrition

# UTILIZATION AND NUTRITION

The OFSP projects implemented nutrition-sensitive activities, including nutrition education and to some extent nutrition counseling, targeted at improving the quality of diets consumed by women caregivers and children under 5 years of age. The study assessed the quality of diets consumed by survey household in two ways. First, it examined dietary diversity at household and individual levels, using dietary diversity scores (DDS) for young children and the mothers/caregivers using the 24-hour recall data collected from each household. Secondly, we assess the consumption of vitamin A rich foods. Before we present nutrition results, we briefly outline how sweetpotato is utilized, that is, the various forms in which sweetpotato is prepared for consumption.

## 6.1 Utilization of sweetpotato

Results indicate that 78% of the respondents consumed sweetpotato in various forms (Table 20), indicating diversified utilization of sweetpotato across the different categories of households. The most common utilization forms are eating fresh roots, boiling and roasting as well as just raw. A large proportion (>99%) of respondents across the categories also eat sweetpotato in boiled form. It is also widely eaten mixed with groundnut sauce, referred to as *Futali*. Consumption of sweetpotato leaves as a vegetable – widely known as *relish* – was also common, and was promoted by nutrition-focused component of sweetpotato projects. More than 35% of women caregivers and children under 5 years consumed sweetpotato leaves at least once during the week preceding the survey. A test of difference in mean number of utilization forms revealed statistically significant difference (p-value = 0.000) between participants and non-participants. The former also had significantly higher average number of utilization forms than the counterfactual households (p-value = 0.000).

The study further found highest consumption of sweetpotato during the harvest months, as expected. The majority of the households consumed sweetpotato at least twice per week, typically around the month of April when harvest is at the peak

**Table 20.** Forms in which sweetpotato is eaten by intervention group

| | Overall sample | Participant | Non-participant | Counterfactual |
|---|---|---|---|---|
| | *(N=2,492)* | *(N=1,421)* | *(N=536)* | *(N=535)* |
| *Forms of consumption* | | (%) | (%) | (%) |
| Boiled | 99.7 | 99.7 | 99.8 | 99.6 |
| Roasted | 93.1 | 93.8 | 93.5 | 91.0 |
| Fried | 37.4 | 43.1 | 34.1 | 25.4 |
| Porridge | 7.4 | 9.6 | 5.4 | 3.6 |
| Futali | 84.2 | 87.5 | 85.6 | 74.2 |
| Raw | 83.4 | 84.5 | 84.7 | 81.7 |
| Other | 4.5 | 5.6 | 3.0 | 3.4 |

## 6.2 Dietary diversity

The dietary diversity scores were computed following FAO guidelines (Swindale & Bilinsky, 2006a&b; Kennedy et al., 2011). The child dietary diversity score (CDDS) was computed based on 8 food groups with a cutoff of 4 food groups for children between 6-23 months. That is, diets comprising less than 4 food groups (i.e., CDDS<4) were considered not diverse enough to provide adequate micronutrients required for children 6-23 months of age. In most populations, the consumption of foods from at least four food groups over 24-hour period means that the child had a high likelihood of consuming at least one animal-source food and at least one fruit or vegetable in addition to a staple food (grain, root or tuber) that day. The dietary diversity for the woman caregiver was, on the other hand, computed using the Minimum Dietary Diversity - Woman (MDD-W) based on 10 food groups with a cutoff of 5 (FAO, 2014; Arimond, 2010; Custodio et al, 2016).

In addition to caregiver and young child food consumption, the study also examined the diversity of foods consumed by the entire household using household dietary diversity score (HDDS). This score measures the number of food groups consumed by a household over a given reference period, usually 24 hours and is a proxy for household economic access to food (Swindale & Bilinsky, 2006a). Lastly, we assessed the frequency of consumption of different kinds of locally available foods focusing on consumption of vitamin A-rich foods, and computed the Helen Keller International (HKI) vitamin A consumption scores for 6-23-month old child and woman caregiver based on 7-day food consumption recall (Hagenimana et al., 2001). The HKI score is a community-level indicator of vitamin A deficiency.

Table 21 presents the actual Dietary Diversity Scores (DDS) for the three categories of households (and their members) interviewed in this study. Young children in all categories of households had DDS lower than the cutoff level of 4 food groups. This finding indicates that, across the household categories, diets consumed by young children the day preceding interview visit could not provide adequate amounts essential micronutrients, hence were of inadequate quality. The results of the Sidak pairwise tests of equality of mean number of food groups consumed between the different categories of households however show that young children in participant households consumed statistically significantly higher number of food groups than their counterparts in counterfactual households.

Table 21 also shows that the diets consumed by caregivers/mothers of young children (i.e., women of reproductive age) did not meet the threshold requirement of five food groups, for the participant, non-participant and counterfactual households. Thus, the foods consumed by caregivers in three categories study households were also not adequate to provide essential micronutrients required by this category of household members. The Sidak pairwise tests of differences in the mean number of food groups consumed by caregivers in the three categories of study participants show that while not attaining the threshold level, the project participants consumed, on average, statistically significantly higher number of food groups than caregivers in counterfactual households. Non-participant households consumed, on average, statistically higher number of food groups than their counterparts in the counterfactual households. That is, compared to young children, the proportion of mothers/caregivers who attained the MDD-W of five food groups or higher was 42% for participants, 39% for non-participant and 28% for counterfactual. Lastly, participant households also had statistically significantly higher economic access to food than the counterfactual households. There was however no difference in terms of economic access

to food between participant and non-participant households living in the same villages. Overall, the HDDS were low across the household categories, averaging only about 5 out of the possible 12 food groups.

**Table 21.** Diet diversity of caregivers and young children (6-23 months)

| | Total | | Participant | | Non-participant | | Counter-factual | | P-value |
|---|---|---|---|---|---|---|---|---|---|
| *Dietary diversity index* | Obs. | Score | Obs. | Score | Obs. | Score | Obs. | Score | |
| | | | (1) | | (2) | | (3) | | |
| CDDS | 1,137 | 3.80 | 649 | 3.86[a,b] | 254 | 3.81[c] | 234 | 3.66 | 0.055 |
| | | (1.07) | | (0.99) | | (1.01) | | (1.00) | |
| MDD-W | 1,298 | 4.18 | 723 | 4.29[a] | 294 | 4.24[c] | 281 | 3.84 | 0.000 |
| | | (1.35) | | (1.40) | | (1.32) | | (1.24) | |
| HDDS | 2,492 | 4.83 | 1,421 | 4.91[a] | 536 | 4.81[ab] | 535 | 4.66b | 0.000 |
| | | (1.52) | | (1.54) | | (1.49) | | (1.49) | |

**Notes**: Standard deviations in parentheses; [a,b,c] denote statistical differences at 1-10% levels between household categories; CDDS: Child Diet Diversity Score; MMD-W: Minimum Dietary Diversity for Women of Reproductive Age (i.e., Caregivers); HDDS: Households Diet Diversity Score.

Figure 4a further examines the proportion of children and caregivers that meet the minimum daily thresholds DDS. Overall, the results indicate that majority of children under five years of age in participant (71%), non-participant (70%) and counterfactual (77%) did not attain the minimum required consumption of at least 4 four food groups during the day preceding the survey. Assessment of percentage of caregivers attaining the threshold consumption of at least five food groups in Figure 4b yields similar results.

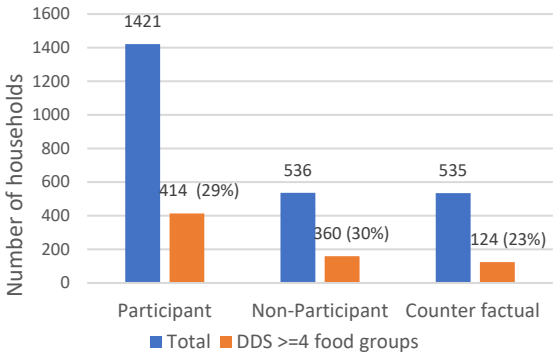



**Figure 4a.** Children minimum dietary diversity score (counts (%))

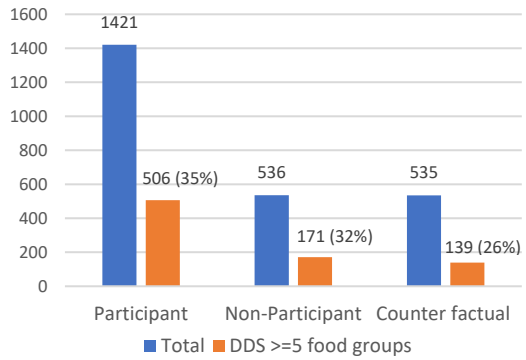



**Figure 4b.** Caregiver minimum dietary diversity score

Table 22 presents differences in diet quality by study region. Quality of diets consumed by the young children and caregivers the day prior to interviews was highest in the Northern region with borderline number of food groups being consumed by young children the day prior to interviews. Young children and caregivers in Central region consumed significantly higher number of foods groups during the 24 hours preceding to the interview than their counterparts in Southern region but did not reach the threshold five food groups requirement. Household economic access to food, captured by HDDS, was also rather low.

Out of the 12 possible foods groups used to compute this score, respondents consumed, on average, less than five groups. Statistical tests found significant difference in mean number of foods groups consumed a day before the interviews in the Northern and Central regions and those in the Southern region. Overall, these findings are in line with our *a priori* expectations. The Southern region is usually considered poorer than the rest, and suffers frequent weather-related shocks, especially floods (WFP, 2018). It was, at the time of study, recovering from a major flooding[10] event that occurred in March 2019 affecting more than 500,000 households.

**Table 22.** Dietary diversity scores for young child, caregiver and household by region

| | Total | | North | | Central | | South | | P-value |
|---|---|---|---|---|---|---|---|---|---|
| *Dietary diversity index* | Obs. | Score | Obs. | Score | Obs. | Score | Obs. | Score | |
| | | | (1) | | (2) | | (3) | | |
| CDDS | 1,137 | 3.80 (1.07) | 87 | 4.09[a,b] (1.19) | 384 | 3.95[c] (0.99) | 666 | 3.68 (1.09) | 0.000 |
| MDD-W | 1,298 | 4.18 (1.35) | 723 | 4.63[a,b] (1.48) | 294 | 4.32[c] (1.28) | 281 | 4.05 (1.36) | 0.000 |
| HDDS | 2,492 | 4.71 (1.50) | 1421 | 5.29[a,b] (1.51) | 536 | 4.99[c] (1.45) | 535 | 4.48 (1.48) | 0.000 |

**Notes**: Standard deviations in parentheses; [a,b,c] denote Sidak test's statistical differences at 1-10% levels between regions. CDDS: Child Diet Diversity Score; MMD-W: Minimum Dietary Diversity Score for Women of Reproductive Age (i.e., Caregivers); HDDS: Households Diet Diversity Score.

## 6.3 Consumption of vitamin A-rich foods based on 7-day recall

The frequency of consumption of different kinds of vitamin A-rich food types for the overall sample is presented in Table 23. The most frequently consumed plant-based vitamin A rich foods were dark green vegetables. In this category of foods, pumpkin leaves were consumed relatively more frequently that amaranth and sweetpotato leaves. Both children and caregivers consumed orange-fleshed sweetpotato roots, on average, at least once during the 7 days preceding the survey. A pairwise Bonferroni test of difference in means, however, found no significant difference (p-value=0.1489) in consumption of pumpkin leaves among children from different categories of households (i.e., participant, non-participant and counterfactual). Using the same test, we find no statistical differences in mean number of days consumption of consumption of sweetpotato leaves by young children (p-value = 0.1698) and caregivers (p-value = 0.1309) across the household categories. Moreover, the same test found no statistical difference (p-value=0.6425) in consumption of dark green vegetables, in general, among caregivers from different categories of households. The study did not find significant differences in consumption of these vitamin A foods by study region. In terms of animal-based vitamin A rich foods, the most frequently consumed food during the 7 days preceding the survey was fish, consumed – on average – at least once a week.

Sweetpotato usually plays an important role as staple food during the hunger months just before maize harvest season when household food stocks dwindle and get depleted. Figure 5 presents typical months of the year when respondents' households consumed sweetpotato at least twice in a month. Across the

[10] https://reliefweb.int/report/malawi/malawi-floods-briefing-note-12-march-2019 (accessed Jan 2021)

three categories of households, consumption of sweetpotato was highest during February, March, and April which coincide with the harvest months. Notably, there was still consumption of small amounts of sweetpotato even in the dry months of the year (i.e., June to December) likely due to the *dambo* crop. Specifically, participant households registered at least some consumption of sweetpotato throughout the year except during the month of November.

**Table 23.** Average number of days vitamin A-rich foods were consumed in one week prior to the study

| | Child | Caregiver |
|---|---|---|
| *Food item* | Mean | Mean |
| Dark green vegetables | 2.89 | 3.54 |
| Sugar fortified with Vitamin A | 2.10 | 2.30 |
| Whole fish (with liver) | 1.30 | 1.60 |
| OFSP | 1.10 | 1.30 |
| Pumpkin leaves | 1.05 | 1.29 |
| Yellow sweetpotato | 0.70 | 0.80 |
| Sweetpotato leaves | 0.66 | 0.78 |
| Egg with yolk | 0.60 | 0.70 |
| Weaners food with vit A | 0.40 | 0.50 |
| Pumpkins | 0.40 | 0.50 |
| Amaranth | 0.19 | 0.22 |
| Papaya | 0.30 | 0.40 |
| Liver | 0.10 | 0.10 |
| Carrots | 0.04 | 0.05 |
| Cod liver oil | 0.03 | 0.04 |
| Passion fruit | 0.01 | 0.01 |
| Palm oil | 0.01 | 0.01 |
| Infant formula with vitamin A | 0.00 | 0.00 |

**Notes**: N=1,298 which represents all households with a child of age <5 at the time of the survey.

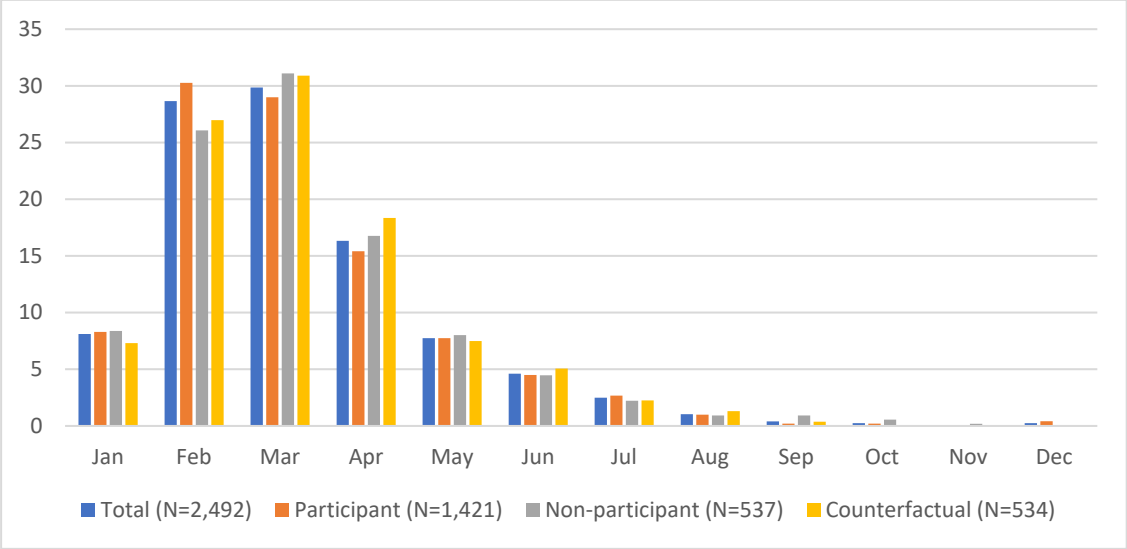



**Figure 5.** Months in which the household consumes sweetpotato at least twice a month by household category

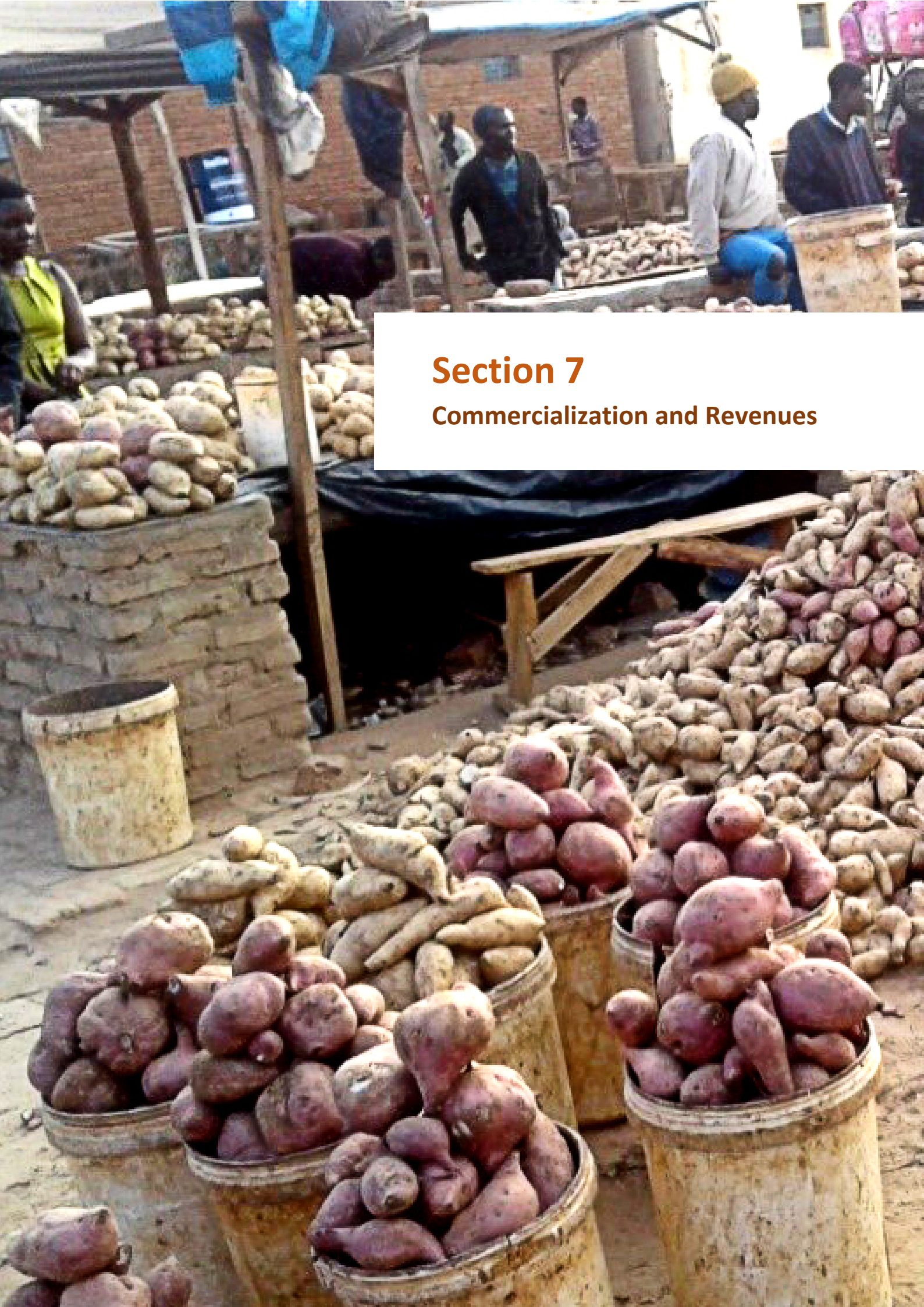
## 6.4 Vitamin A consumption scores

Table 24 presents the vitamin A consumption scores for the 6-23-months old child and woman of reproductive age both by household category and the region of the country. The cut-off score for this semi-quantitative index for animal-sourced and total vitamin A scores are 4 and 6, respectively. The results show that the participant households consumed significantly higher amounts of vitamin A from animal sources, and from plant and animal sources combined, than the counterfactual households. However, there was no significant difference in frequency of vitamin A vitamin A consumption scores (from animal and total sources) between participants and non-participants living in the same communities. Results further show, in line with the earlier findings, that there was higher consumption of vitamin A in Northern and Central regions than those in the Southern region.

**Table 24.** Frequency of Vitamin A consumption by young child and woman of reproductive age

| | | Intervention group | | | | Region | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Part.** | **Non-participant** | **Counter-factual** | **p-value** | **North** | **Central** | **South** | **p-value** |
| | | *(N=772)* | *(N=291)* | *(N=281)* | | *(N=109)* | *(N=415)* | *(N=770)* | |
| | | Mean | Mean | Mean | | Mean | Mean | Mean | |
| *Vit A source* | | (1) | (2) | (3) | | (1) | (2) | (3) | |
| Animal-source VA score | Woman | 5.97[a] | 5.64[a] | 5.00[b] | 0.001 | 8.37[a] | 6.67[b] | 4.77[c] | 0.00 |
| | Child | 5.32[a] | 4.89[a] | 4.14[b] | 0.001 | 6.56[a] | 6.20[b] | 4.08[c] | 0.00 |
| Total VA score | Woman | 6.81[a] | 6.36[a] | 5.69[b] | 0.026 | 9.37[a] | 7.42[b] | 5.52[c] | 0.00 |
| | Child | 6.04[a] | 5.48[a] | 4.64[b] | 0.004 | 7.34[a] | 6.90[b] | 4.67[c] | 0.00 |

**Notes**: [a,b,c] denote Sidak pairwise test of difference in means between household categories and regions



# Section 7

## Commercialization and Revenues

# COMMERCIALIZATION AND REVENUES

This section presents results of the commercialization part of OFSP in Malawi. First, market survey results, such as seller and price details, conducted across Malawi are presented. Prices are compared with variety Kenya to analyze if premiums are received for OFSP varieties. Second, revenues from OFSP and how revenues are utilized are presented. In addition, insights are given into decision-making on OFSP marketing and revenue utilization.

## 7.1 Market survey: methods

The study conducted seller interviews in 41 markets across Malawi: 13 in the Southern region, 23 in the Central and 5 in Northern Malawi. In each market, a random walk was used to select sweetpotato and OFSP vendors. Attention was paid to include male and female vendors. Sampling of markets did follow a convenience sampling strategy. To analyze commercialization differences, at least one market was selected per EPA. Another selection criterion was that markets should represent major markets for agricultural commodities catered to rural people rather than urban consumers. Therefore, supermarkets, for instance, were not eligible. Market data were collected by a team of two survey supervisors targeting main markets used by most of the households surveyed. The main data collected were: number of sweetpotato sellers, both OFSP and non-OFSP; quantity sold and price of sweetpotato varieties (Kenya, OFSP, non-OFSP local varieties, mixed local varieties); main substitute and its price. To obtain prices for standard volumes, piles of sweetpotato and cassava roots were weighed using a standard scale.

## 7.2 Market survey: sellers

Availability of OFSP in markets was low: of the 41 surveyed markets, only 17 had OFSP at the time of the survey. This is not surprising as the survey was done after the peak harvesting period. Most of the markets without OFSP were in the Central Region (15 food markets out of 23). This is striking, given OFSP harvest was in full swing and suggests that OFSP plays an important role in home consumption.

The market for sweetpotato roots was gender-balanced with one-half of the sellers being women. However, just one-quarter of those women sold OFSP. In total, 15.7% of sweetpotato sellers traded in OFSP, fluctuating from 11.8% in the northern region to 18.6% in southern regions (Table 25). Results also show that the composition of the markets in terms of sweetpotato varieties being sold was different across markets. Of the 41 markets, 25 had Kenya (61%) and 29 had local varieties (71%). Among the 25 markets in which Kenya was present, 4 had only Kenya (two in central region and two in southern region), while of the 29 markets selling local varieties five (one in northern region, two in central region and two in southern region) did not have any improved varieties. None of the markets had only OFSP, as a single flesh type. In all markets, the most dominant substitute for sweetpotato was cassava, followed by potato, yams, and cooking bananas.

**Table 25.** Distribution of sweetpotato sellers across study markets, % by region and seller type

| | Markets | Women selling sweetpotato | Women selling OFSP | OFSP sellers |
|---|---|---|---|---|
| *Region* | (#) | (%) | (%) | (%) |
| Central | 23 | 43.9 | 32.9 | 14.8 |
| North | 5 | 70.4 | 16.8 | 11.8 |
| South | 13 | 53.3 | 22.4 | 18.6 |
| **Total** | **41** | **50.4** | **26.7** | **15.7** |

## 7.3 Market survey: prices

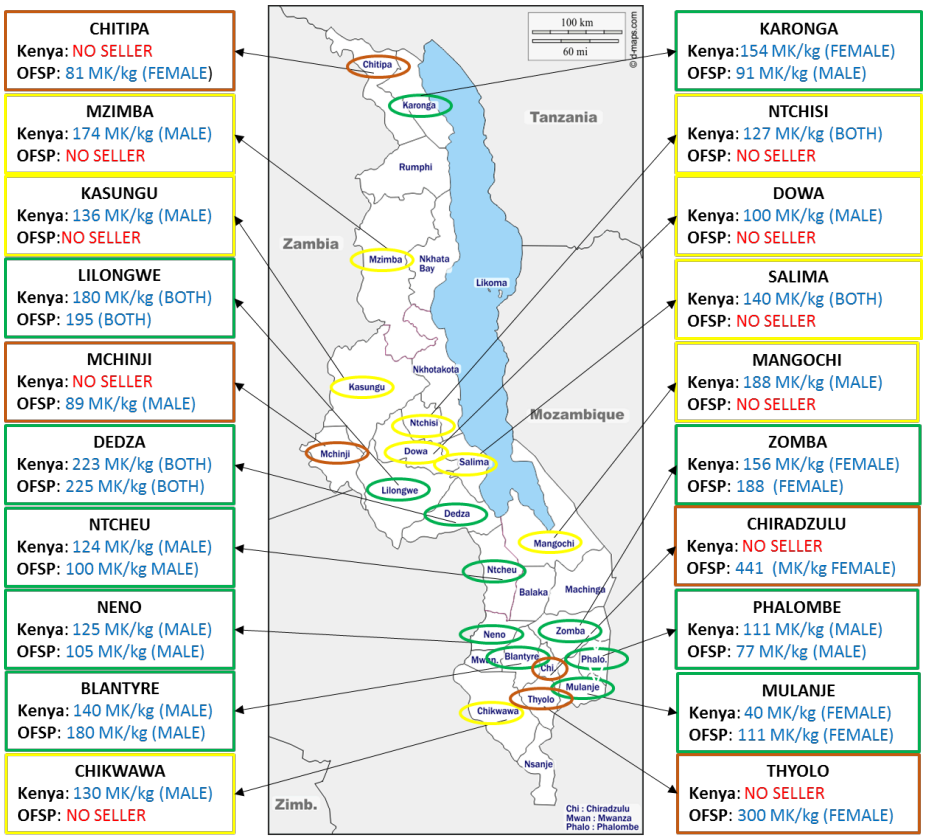
In terms of prices, OFSP roots sold at markets by different sellers across Malawi were, overall, not statistically different from roots sold for variety Kenya (Table 26). Despite the seemingly drastic regional differences, market price differences across the country were statistically insignificant. However, this is likely due to small number of observations, but the results are likely indicative of real differences we would observe if we had a larger sample.

These were likely the following: the high price range observed for OFSP across Malawi is positively correlated with OFSP intervention intensity. In the Central and especially in the South, OFSP interventions were more intense compared with the North, possibly creating higher demand and willingness to pay a premium for nutritious food. In line with this, a substitution effect possibly resulted in lower demand for Kenya and thus a drop in prices: in the South, Kenya prices dropped by 17.5% from the national mean price.

**Table 26.** Average market prices (MK/kg) at markets across Malawi 2019

| | OFSP | | | | Kenya | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | | Female | Male | Total | | Female | Male |
| *Region* | Obs. | Mean | Mean | Mean | Obs. | Mean | Mean | Mean |
| Total | 17 | 173 | 219[a] | 141 | 24 | 154 | 157 | 152 |
| North | 2 | 86 | 81 | 91 | 2 | 164 | 154 | 174 |
| Central | 8 | 171 | 206 | 160 | 15 | 165 | 181 | 157 |
| South | 7 | 200 | 260[a] | 121 | 7 | 127 | 98 | 139 |

**Notes**: no significant differences found between total mean values for OFSP and Kenya. [a] significant different at 5%-level comparing female and male in either OFSP or Kenya group. No t-test conducted for values in North region as N=2. Market prices did not statistically differ between region except for prices obtained in South and Central parts (p=0.07). Two markets in Lilongwe district were excluded as these were outliers having 6 times higher OFSP prices Exchange rate: MK=Malawian Kwacha. USD 1=MK 679 at the time of the survey.




**Map 2.** Market prices (MK/kg) for OFSP and Kenya in Malawi by district and gender

**Note**: Color of the circles/price info box correspond to the presence of OFSP and/or Kenya varieties in the markets surveyed in those Districts at the time of the survey. Green (both OFSP and Kenya were found in markets), Yellow (no OFSP, but Kenya was found in markets), and orange (no Kenya, but OFSP was found in markets).

Gender also played an important role in the commercialization of OFSP. For Kenya, the study found that prices were similar for both female and male sellers: average root price were between 152 and 157 MK/kg, respectively. In contrast, for OFSP varieties, it was found that females sellers received on average a significantly 55% higher price compared to male sellers (219 MK/kg versus 141 MK/kg). This observed price gap for OFSP was especially the case in the South and Central regions, whereas in the North prices were similar. Kenya prices in the South were the lowest for both female and male sellers compared to the other regions. In the Central and North, however, Kenya prices were fairly similar (Table 26). The finding that women fetched higher market prices for OFSP than their male counterparts may partly be accepted as women have higher negotiating power vis-à-vis women and convince them of the nutritional benefits. Women, as primary caregivers, usually take on the responsibility to purchase food items and the higher willingness to pay for OFSP varieties (as reflected in relatively higher market prices) may be due to children's clear preferences for OFSP (Hummel et al., 2018).

The highest OFSP prices were received in Thyolo and Chiradzulu districts (Southern region) and were obtained by female sellers (Map 2). These two observations appear to drive the total average results for OFSP prices. In contrast, lowest OFSP price (81 MK/kg) was observed in Chitipa district (Northern region). Map 2 further disaggregates market prices for OFSP and Kenya varieties by district and gender.

Interestingly, market prices appeared to be highly localized. Take the example of Thyolo, Chiradzulu, Mulanje, and Phalombe districts. Despite of being neighboring districts, OFSP prices differed considerably.

## 7.4 Sweetpotato revenues

Revenues from sweetpotato sales reveal that households received an average of MK 8,297 for the entire season. There are no differences across intervention groups (Table 27). Notably, there was very wide variation in the value of sweetpotato sales within different categories of households, as shown by the large standard deviations of the means. There are no statistically significant differences in sales revenues between regions (Table 28). Respondents in the central region earned the highest revenue from sweetpotato sales, perhaps due to proximity to a metropolitan markets (Lilongwe) with higher prices. But it also had the highest variation in terms of revenues earned.

**Table 27.** Revenues from sweetpotato sales for 1 season by intervention group

| | Total | Participant | Non-participant | Counterfactual | P-value |
|---|---|---|---|---|---|
| | *(N=2,233)* | *(N=1,210)* | *(N=506)* | *(N=517)* | |
| Revenue (MK) | 8,297 | 8,115 | 8,891 | 8,140 | 0.3804 |
| | (12,614) | (1,210) | (12,903) | (12,770) | |

**Notes:** MK=Malawian Kwacha. USD 1=MK 679 at the time of the survey. Standard deviations in parentheses.

**Table 28.** Revenues from sweetpotato sales for 1 season by region

| | Total | North | Central | South | P-value |
|---|---|---|---|---|---|
| | *(N=2,233)* | *(N=227)* | *(N=803)* | *(N=1,575)* | |
| Revenue (MK) | 8,297 | 6,271 | 10,973 | 6,683 | 0.3804 |
| | (12,614) | (11,346) | (14,034) | (11,385) | |

**Notes:** MK=Malawian Kwacha. USD 1=MK 679 at the time of the survey. Standard deviations in parentheses.

In terms of decision-making, results show that – overall – most of the sale decisions were made jointly (Figures 6 & 7). However, slightly more women are involved in the decision on how revenue from sale of sweetpotato roots is used. Sidak pairwise tests of difference frequencies nonetheless find no significant differences between female and males on both the decision on how much of the roots to sell and control of revenues from sales.

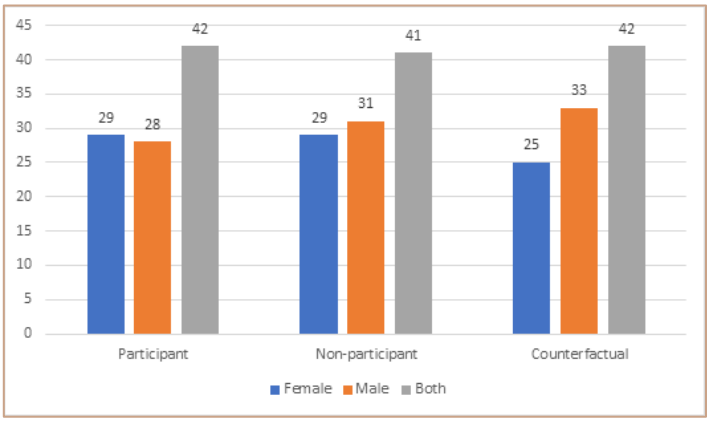



**Figure 6.** Decision on quantity of sweetpotato roots sold if any by gender (% of the answers)

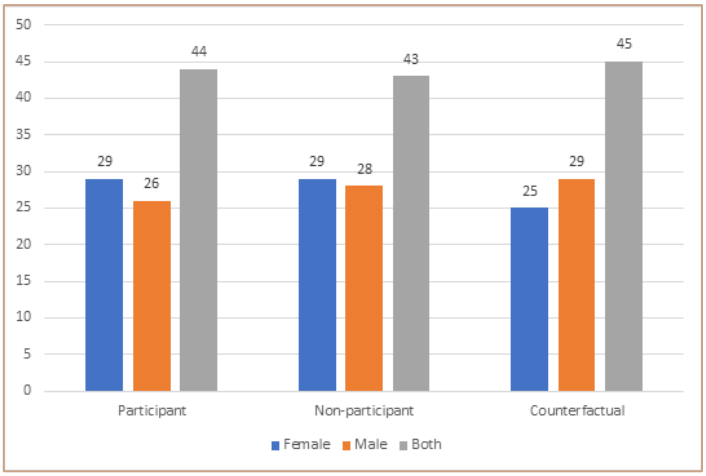



**Figure 7.** Decision on how revenue from sale is controlled by gender (% of the answers)

# Section 8

## Robustness Validation of Key Variables

# ROBUSTNESS VALIDATION OF KEY VARIABLES

The results of a sweetpotato household survey generally come with some challenges associated with reliability of data for farmers' identification of varieties, farmers' estimation of plot areas and quantities of produce harvested and subsequent yield calculations. This section presents the methods and results of three validation activities that were conducted to add more understanding to the results of the household survey. In the first activity (8.1), leaf sampling and DNA fingerprinting was conducted to assess the correctness of varietal identification by farmers. In the second activity (8.2), area measurements were calculated through GPS and measurement tape, to compare these with farmers estimates of plot sizes. In the third activity (8.3), sweetpotato crop-cuts were conducted in farmers' fields across the country, to compare survey yields with yields measured in the field.

## 8.1 Varietal identification by DNA fingerprinting

The use of varietal identification through fingerprinting technologies is not only useful to correctly identify the variety, but also to estimate the errors in the varietal identification. This includes both false positives where farmers believe they have a specific variety when they do not (also known as error type I); and false negatives where farmers believe they do not have the specific variety, when indeed they have it (also known as error type II). Error type I and Error type II are calculated based on the genotyping identification and the farmer naming of varieties. Those errors commonly occur in these types of studies as reported by Wineman et al. (2020) in maize and rice, Kosmowski et al. (2018) in sweetpotato, Floro et al., (2017) in cassava, Maredia et al. (2016) in cassava and beans, Rabbi et al. (2015) in cassava, Labarta et al., (2015) in rice. Reasons to misidentify varieties by farmers can be attributed to incorrect information on the varieties they are growing, problems remembering correctly, variety has been renamed, or mixtures of varieties have occurred over time. All of these reasons have made it important to validate the survey information by fingerprinting a subsection of samples found in the field, then data triangulate between the information coming from the DNA fingerprinted, farmer's variety declared at plot level, and farmer's variety declared in the household survey.

### Methodology

The method included a leaf sampling procedure that was aligned to the overall sampling design. A team of seven leaf collectors where intensively trained in collecting leaf samples following strict procedures which are documented in sample protocols. The leaf collectors were accompanying the teams that were collecting household-level data for the adoption survey. After the first round of interviews were completed, leaf collectors would follow farmers to their plots to take leaf samples. This was challenging as not all plots were near the farmer's house and frequently, leaf collectors needed to walk (off-road) for some 1.5 hours one way. Mainly households that participated in OFSP projects were selected for leaf sample collection, but also non-participants in intervention villages. This strategy increased the likelihood of sampling OFSP varieties. Per intervention village, a total of four households were randomly selected.

Given the overall research design, the study expected to sample a total of 524 households. However, leaf samples were collected from 388 households in all sampled EPAs resulting in a collection of 1,039 leaf samples. The reduction in households was due to two reasons. First, oftentimes farmer plots were very far away from the location where interviews were conducted and not accessible by car. This was especially an issue in the South where the study started with the data collection. Secondly, as data collection progressed toward the Northern region, many fields had already been harvested. Delays of one month in the start of data collection due to the fear of theft, livestock damage and post-election violence in 2019 contributed to this. To reach our intended targets, the study changed the sampling design in two ways. First, the restriction on non-participant households which were at that stage was eased to included also for leaf sampling. Secondly, where possible, vine re-sprouts were sampled.

DNA extraction and fingerprinting were done through Diversity Arrays Technology, which is a generic and cost-effective genotyping technology detecting all types of DNA variation (SNP, indel, CNV, methylation). It was invented by Andrzej Kilian and his group (Kilian et al, 2012) to overcome some of the limitations of other molecular marker technologies such as RFLP, AFLP, and SSR. Their prices are significantly less expensive than other alternatives. Furthermore, this project required the use of the same platform as employed in previous projects so that data generated in this project could be compared and analyzed to data generated from other projects (i.e. – genotyping of the *ex-situ* accessions, the 100 best bets of Africa, and varietal adoption of different crops in Africa). This assisted in varietal identification.

The leaf sampling activity generated three databases: 1) DNA fingerprinting varietal identification for selected households, 2) Varietal identification through farmer elicitation at plot level, during sweetpotato leave collection, and 3) Varietal identification through farmer elicitation for the corresponding sub-sample of the household survey that were selected for DNA fingerprinting. Database 1 (DNA) was used for identification of sweetpotato varieties by DNA fingerprinting, Database 3 (Household) was used to estimate the varietal misidentification. Database 2 (Farmer at plot) was used to identify varieties with no reference material in the DNA fingerprinting work.

Results of the genotyping identification were compared to the household survey. It was not possible to confidently match all samples from the DNA study to the household survey. Therefore, 14 samples were withdrawn, and 955 samples from 378 households were used for the comparison (Table 29). More than half of the farmers were planting OFSP varieties though this was less in Northern region (29% of farmers) then Central (57%) and Southern regions (62%). Farmers that cultivated OFSP, on average, had 1.1 OFSP varieties per farmer in the Northern region, and 1.5 OFSP varieties in Central and Southern Region.

**Table 29.** Summary of data produced in the genotyping activity with respect of number of farmers planting OFSP, and varieties planted in farmers plots in Malawi

| | Total farmers | OFSP farmers | Total SP varieties | DARS-CIP OFSP varieties | Farmers with DARS-CIP OFSP variety |
|---|---|---|---|---|---|
| *Region* | Obs. | Obs. | Obs. | Obs. | (%) |
| North | 51 | 15 | 131 | 17 | 29 |
| Central | 174 | 99 | 456 | 151 | 57 |
| South | 153 | 95 | 368 | 142 | 62 |
| ***Total from genotyping subsample*** | ***378*** | ***209*** | ***955*** | ***310*** | ***55*** |

## Results of DNA fingerprinting

The DNA fingerprinting resulted in good quality DNA for 98% of the 991 household samples (969 samples) for varietal confirmation. From those, a striking 422 did not match (42.5%) any of the reference material (163 single unknown varieties were identified from those 422 unknown samples). The total number of uniquely identified genotypes were 175. The rich sweetpotato diversity in Malawi is in line with earlier findings (Chipungu et al., 2017). Table 30 shows the frequency of the most common varieties cultivated in the different fields of Malawi. The most important varieties were Kaphulira, Kenya, and Kadyaubwerere, with 12.7%, 11.1% and 9.8%, of the samples collected, respectively. These results show the importance of Kaphulira and Kadyaubwerere as the most important OFSP present in the country. Kenya also appeared as important in the samples from participant villages. A relatively high adopted unknown OFSP variety (named as Unknown 1) was present in 89 samples. This variety was given 28 different names by farmers during data collection, and one third of farmers did not know the name of the variety (naming it as other OFSP or unknown). It would be important to identify this variety as it seems to be a high impact OFSP variety which is present mostly in Central region, mainly in Mchinji. Mugamba was considered as the most important local variety in several districts.

**Table 30.** Percentage of the most frequent sweetpotato varieties that matched with the most common varieties sent from the Malawi Research Station, and the 100 best bets project to DarT P/L, and the percentage of most frequent varieties identified in the recall data from survey.

| *No.* | *Varieties identified by DNA data* | *%* | *Varieties identified by Recall data* | *%* |
|---|---|---|---|---|
| 1 | Kaphulira (1) | 13% | Kenya | 13% |
| 2 | Kenya | 11% | Kadyaubwerere (2) | 10% |
| 3 | Kadyabwerere (2) | 10% | Kaphulira (1) | 6% |
| 4 | “Unknown 1” | 9% | Mugamba | 6% |
| 5 | Mugamba | 8% | Zondeni (3) | 4% |
| 6 | Zondeni (3) | 6% | Ana akwanire (6) | 4% |
| 7 | Mwanza purple | 4% | Mathuthu (4) | 4% |
| 8 | “Unknown 2” | 2% | Chipika (5) | 4% |
| 9 | “Unknown 3” | 2% | Unknown | 3% |
| 10 | Mathuthu (4) | 2% | Research | 2% |
| 11 | Chipika (5) | 1% | OFSP | 2% |
| 12 | Ana akwanire (6) | 1% | Other OFSP | 2% |
| 13 | “Unknown 4” | 1% | Salera | 2% |
| 14 | Semusa | 1% | John | 2% |
| | Others (N= 157) | 30% | Others (N= 144) | 37% |
| | **OFSP (1+2+3+4+5+6)** | **32%** | **OFSP (1+2+3+4+5+6)** | **30%** |

The varietal identification by DNA showed that fewer OFSP varieties were found in the Northern regions in comparison to Central and Southern regions (Table 31). The districts with higher presence of OFSP were Nsanje, Mangochi and Mwanza in the South, and Dedza, Lilongwe and Salima in the Central region. Kenya variety was more important in the Central region, especially in Ntchisi, Dowa, and Mchinji. Local varieties were grown across the country, being more important in the Northern region with 56% of total

sweetpotato samples collected in the region. Districts with a higher percentage of local varieties are Karonga and Rumphi in the North, Ntcheu and Ntchisi in Central region and Balaka and Blantyre in the South. Kaphulira and Kadyaubwerere were both important in Districts such as Thyolo, Salima, Lilongwe, and Zomba. While Kadyaubwerere was important in Blantyre, and Kaphulira was also important in Dedza, Kenya variety was especially relevant in Ntchisi, Chitipa, Dowa, Dedza and Lilongwe.

**Table 31.** Distribution of sweetpotato categories identified by DNA fingerprinting in Malawi by District and Region in Malawi, 2019

| | | OFSP | Kenya | Dominant WFSP | Other local varieties |
|---|---|---|---|---|---|
| *District* | (Obs.) | (%) | (%) | (%) | (%) |
| **Northern Region** | **131** | **14** | **8** | **22** | **56** |
| Chitipa | 19 | 0 | 21 | 11 | 68 |
| Karonga | 24 | 8 | 0 | 4 | 88 |
| Mzimba | 54 | 22 | 11 | 28 | 39 |
| Nkhata Bay | 32 | 13 | 0 | 34 | 53 |
| Rumphi | 2 | 0 | 0 | 0 | 100 |
| **Central Region** | **467** | **33** | **15** | **12** | **40** |
| Dedza | 42 | 48 | 19 | 10 | 24 |
| Dowa | 42 | 24 | 24 | 10 | 43 |
| Kasungu | 6 | 33 | 17 | 0 | 50 |
| Lilongwe | 72 | 43 | 19 | 10 | 28 |
| Mchinji | 106 | 31 | 22 | 5 | 42 |
| Nkhotakota | 49 | 12 | 10 | 33 | 45 |
| Ntcheu | 32 | 25 | 6 | 6 | 63 |
| Ntchisi | 18 | 11 | 28 | 6 | 56 |
| Salima | 100 | 41 | 3 | 19 | 37 |
| **Southern Region** | **371** | **39** | **8** | **9** | **44** |
| Balaka | 19 | 21 | 0 | 5 | 74 |
| Blantyre | 14 | 21 | 7 | 0 | 71 |
| Chiradzulu | 13 | 15 | 15 | 8 | 62 |
| Machinga | 62 | 27 | 5 | 11 | 56 |
| Mangochi | 24 | 63 | 0 | 0 | 38 |
| Mulanje | 85 | 31 | 12 | 9 | 48 |
| Mwanza | 5 | 60 | 0 | 0 | 40 |
| Neno | 13 | 38 | 0 | 0 | 62 |
| Nsanje | 3 | 67 | 0 | 33 | 0 |
| Phalombe | 13 | 38 | 8 | 31 | 23 |
| Thyolo | 80 | 59 | 14 | 10 | 18 |
| Zomba | 40 | 43 | 0 | 10 | 48 |

## Varietal misidentification

The extent to which household respondents were able to correctly identify the varieties they were growing in the field at the time of the survey is presented in Table 32. For all promoted OFSP varieties, and Kenya as reference, the table reveals how often respondents in the household survey stated that they were cultivating those varieties. For instance, the OFSP variety Kadyabwerere was mentioned most frequently

(87 times), followed by Kaphulira (52 times) and Chipika (44 times). Jointly, promoted OFSP varieties were mentioned 289 times. In contrast, Kenya was overall the most frequently mentioned variety (131 times). The DNA fingerprinting results could only partly confirm the survey results. First, several varieties were over-reported (i.e., Chipika, Anaakwanire, Mathuthu, Kenya), while others were under-reported (i.e., Kaphulira, Zondeni, Kadyaubwerere). Second, looking at the frequencies obtained from DNA fingerprinting, correct varietal identification (true positives) ranged between 9-37%. For instance, Chipika was only correctly identified in 9% of the cases, Kaphulira being the most frequently correctly identified OFSP variety (35%) and Kenya being overall the most frequently correctly identified (37%). Comparing survey with DNA fingerprinting results painted a similar picture. Take the example of the over-reported variety Chipika: it was reported to be cultivated 44 times while it was found to be cultivated 11 times by farmers across the total sample. In only 11% of the cases farmers correctly identified Chipika. Overall, a match between survey and DNA results ranged between 11-87%. Respondents correctly identified Kaphulira the most frequently (87%). Overall, this suggests that farmers were to a large extent unaware of the actual variety identity.

**Table 32.** True positive, Error type I and Error type II per OFSP variety and Kenya variety in Malawi

| | Number of varieties identified in Survey | Number of varieties identified by DNA | True positive Survey ✗= DNA✗ | | False positive Survey ✓≠ DNA✗ | | False negative Survey ✗≠ DNA ✓ | |
|---|---|---|---|---|---|---|---|---|
| *Variety* | (#) | (#) | (#) | (%) | (#) | (%) | (#) | (%) |
| Kaphulira* | 52 | 121 | 45 | 35 | 7 | 5 | 76 | 59 |
| Zondeni* | 33 | 53 | 16 | 23 | 17 | 24 | 37 | 53 |
| Kadyabwerere* | 87 | 94 | 47 | 35 | 40 | 30 | 47 | 35 |
| Chipika* | 44 | 14 | 5 | 9 | 39 | 74 | 9 | 17 |
| Anaakwanire* | 42 | 12 | 10 | 23 | 32 | 73 | 2 | 5 |
| Mathuthu* | 32 | 16 | 11 | 30 | 21 | 57 | 5 | 14 |
| Kenya | 131 | 106 | 64 | 37 | 67 | 39 | 42 | 24 |
| CIP-promoted OFSP (6 OFSP varieties)* | 289 | 310 | 192 | 47 | 97 | 24 | 76 | 29 |

**Notes**: ✓means that it was identified by the specific method, ✗means that it was not identified by the specific method. True positive: farmers reported in the household survey they do have the specific variety, and the DNA fingerprinting demonstrate they do have it; False positive: farmers reported in the household survey they have a specific variety when DNA fingerprinting shows they do not (also known as error type I); False negative: farmers reported in the household survey they do not have the specific variety, when DNA fingerprinting shows they have it (also known as error type II). OFSP varieties are marked with (*)

Through DNA fingerprinting method it was further investigated that the direction of the error included: did farmers report to have a specific variety while they actually do not have it (false positive: error type I)? And if this was the case, what did farmers grow instead (false negative: error type II)? Error I was

frequently the case for Chipika (74%), Anaakwanire (73%), Mathuthu (57%), and Kenya (39%). Not surprising that these are the varieties we earlier mentioned to be over-reported. Instead of having had one of these over-reported varieties, farmers likely had one of the following under-reported varieties instead: error II was most frequently the case for Kaphulira (59%), Zondeni (53%), and Kadyaubwerere (35%). In sum, while farmers to a large extent misidentified the specific variety they were growing, it was observed that, first, all promoted varieties, jointly, were under-reported which means that in some 29% of the sampled cases respondents unknowingly cultivated a promoted OFSP variety. Second, non-OFSP variety Kenya was found to be over-reported by 15%.

**Table 33.** Error type I and error type II for OFSP varieties group by intervention group and region

| | Participant | | | | Non-participant | | | |
|---|---|---|---|---|---|---|---|---|
| | **True negative** | **False negative** | **False positive** | **True positive** | **True negative** | **False negative** | **False positive** | **True positive** |
| *Region* | (%) | (%) | (%) | (%) | (%) | (%) | (%) | (%) |
| North | 80 | 7 | 7 | 6 | 79 | 6 | 8 | 7 |
| Central | 59 | 15 | 8 | 18 | 55 | 15 | 10 | 20 |
| South | 48 | 11 | 14 | 28 | 48 | 10 | 13 | 28 |

**Notes:** True negative: farmers reported they do not have the specific variety, and indeed they do not have it;

**False positives:** farmers reported they have a specific variety when they do not (also known as error type I);

**False negatives:** farmers reported they do not have the specific variety, when indeed they have it (also known as error type II); True positive: farmers reported they do have the specific variety, and indeed they do have it.

Misidentification varied across Malawi and groups. Table 33 shows differences in error type I and error type II in the regions by the different intervention groups. Error type I and error type II were similar in the northern region, while in Central region error type II was larger than error type I and in southern region it was the opposite error type I was larger than error type II. Most errors type I and type II are concentrated in certain districts, such as Salima (19.5% of error type II), Mchinji (14.4% of error type II) in Central region, and Machinga (16.5% of error type I), and Mulanje (12.4% of error type I) in Southern region.

### Varietal misidentification based on farmer responses on flesh-colour

Our results demonstrate that not only were variety names misidentified, but we also found an error in flesh color. Reasons for this could be that farmer confuse the type of planting material they have in the fields, but also a linguistic difference could be at play as Chichewa (the local language) does not have a word for orange; the closest color is “red (yofiira)” which is normally used to describe “orange” fleshed sweetpotatoes, whereas some farmers may also use the word “yellow (chikasu)”. This demonstrates how linguistic categories can impact the answers to survey data. In about 65% of the cases, farmers correctly matched the variety name with the corresponding flesh color for the 10 most adopted varieties (Table 34). Recently introduced OFSP varieties were more often correctly identified (between 69% and 83%) than older varieties (between 28% and 77%). A possible explanation for this misidentification could include mixing up of words in the local language for orange and yellow. Also, farmers reported more than 1,300 different variety names, many of which could be the same variety but with a different (local) name.

**Table 34.** Percentage of correct flesh color identification of most adopted varieties in the household survey in Malawi, N=2492.

| *Variety name* | True color | Correct flesh color identification[a] | |
|---|---|---|---|
| | | (#) | (%) |
| Kenya | Yellow | 880 | 77 |
| Kamchiputu | Orange | 229 | 63 |
| John | Orange | 90 | 31 |
| Kadyaubwerere | Orange | 504 | 83 |
| Zondeni | Orange | 161 | 74 |
| Anaakwanire | Orange | 307 | 72 |
| Chipika | Orange | 216 | 69 |
| Mathutu | Orange | 172 | 69 |
| Kaphulira | Orange | 177 | 72 |
| Mugamba | Cream | 130 | 28 |

**Notes**: [a] correct identification is achieved when farmers' responses to the question of variety name match the responses to the question of flesh color of that variety.

To conceptualize our results, in Kosmowski et al. (2018), 20% of farmers identified a variety as improved when in fact it was local and 19% identified a variety as local when it was in fact improved. According to these authors, the variety names given by farmers delivered inconsistent and inaccurate varietal identities which is why genotyping can help validate the true identity of what is growing in the farmer's fields.

## 8.2 Area measurement

Great uncertainty exists for farmer-stated land area measurements. However, area estimation is key for any assessment of adoption of improved agricultural technologies. If the area is under- or overestimated, so will be the corresponding adoption figures, and results may be distorted. Some studies revealed systematic error in self-reported measures (World Bank, 2016, Carletto et al. 2015) and proposed other methods to overcome this limitation. There are three main methods for estimating area; self-reporting area, rope and compass, and GPS based measurement (World Bank, 2016). While the increase in accuracy of portable electronic devices with GPS capabilities has opened new opportunities to improve area measurement, World Bank (2016) indicates that GPS measurement have small errors in plots over 360 $m^2$, but errors of +/- 10% are not uncommon in smaller plots. The use of compass and ropes also needs some expertise to get the precision needed no matter how careful the training is. Taking area plot measurements is often challenging due to resource limitations. This includes not only time constraints (traveling to farmers' plots is time-intensive), but also human, financial, and logistic constraints.

### Methods

Plot measurements were collected in the fields of 381 households across Malawi (Table 35). These included farmers' self-reported area (obtained from the household survey), GPS measurements, and measurements with a rope/measurement tape. The enumerators did not use a compass to help to get the right shape due to limitations in the acquisition of compasses, and due to lack of expertise in calculating shapes of irregular forms. World Bank (2016) mentioned that small areas tend to have higher GPS error compared to rope measurements with a threshold of 360 $m^2$. Therefore, we defined eight categories to observe the error discrepancies among different measurement instruments. These categories were: Large (>2000 $m^2$), Large low (1000-2000 $m^2$), Medium high (800-1000 $m^2$), Medium (500-800 $m^2$), Medium low (200-500 $m^2$), Small (100-200 $m^2$), Very small (50-100 $m^2$), and Extremely small (<50$m^2$).

### Results

The data presented in Table 36 reveals that farmers from the North have smaller plots than Central and Southern regions in Malawi, based on measurements with tape and GPS. Differences between declared area and area calculated through measurement tape and GPS were larger in the Northern region, especially in Nkhata Bay and Rumphi, than in the other two regions.

Nonetheless, high discrepancies were also found in Central (Ntcheu and Ntchisi districts) and Southern region (Mwanza, Neno and Nsanje districts). It is important to point out that fewer plots were measured in districts with higher discrepancies.

As presented in Table 35, the discrepancy between the three measurement instruments was smallest for plot sizes ranging from 500 to 2000 $m^2$ plot. Farmers with small plots (smaller than 1000 $m^2$) tend to over-

report plot size, while farmers with plots over 2000 $m^2$ tend to under-report plot size. In our case, correction factors are recommended for farmer-reported plot sized of less than 700 $m^2$, and more than 1500 $m^2$. Our results are consistent with those reported in literature (World Bank, 2016). Discrepancies were generally uncorrelated with any household characteristics such as education, age, gender, or occupation (Carletto et al., 2015).

**Table 35.** Discrepancies between mean areas by different measurement instruments by district and region

| | Total HHs | Tape -based area | GPS -based area | Self-reported area | GPS vs. Self-reported diff. | GPS vs. Tape diff. | Tape vs. Self-reported diff. |
|---|---|---|---|---|---|---|---|
| *District* | Obs. | ($m^2$) | ($m^2$) | ($m^2$) | (%) | (%) | (%) |
| **Northern Region** | **55** | **556** | **500** | **822** | **-39** | **-10** | **-32** |
| Chitipa | 5 | 314 | 286 | 802 | 64 | -9 | -61 |
| Karonga | 12 | 355 | 367 | 443 | 17 | 4 | -20 |
| Mzimba South | 18 | 862 | 760 | 781 | 3 | -12 | 10 |
| Nkhatabay | 14 | 484 | 415 | 940 | 56 | -14 | -49 |
| Rumphi | 6 | 406 | 363 | 1,445 | 75 | -11 | -72 |
| **Central Region** | **166** | **832** | **759** | **1,067** | **-29** | **-9** | **-22** |
| Dedza | 15 | 665 | 579 | 879 | -34 | -13 | -24 |
| Dowa | 13 | 348 | 318 | 775 | -59 | -9 | -55 |
| Kasungu | 4 | 738 | | 521 | | | 42 |
| Lilongwe East | 5 | 393 | 364 | 988 | -63 | -7 | -60 |
| Lilongwe West | 18 | 371 | 365 | 506 | -28 | -1 | -27 |
| Mchinji | 38 | 1,030 | 939 | 1,192 | -21 | -9 | -14 |
| Nkhotakota | 19 | 1,219 | 1,208 | 1,915 | -37 | -1 | -36 |
| Ntcheu | 11 | 885 | 686 | 386 | 78 | -22 | 129 |
| Ntchisi | 8 | 373 | 253 | 1,271 | -80 | -32 | -71 |
| Salima | 35 | 1,055 | 959 | 1,188 | -19 | -9 | -11 |
| **Southern Region** | **160** | **826** | **781** | **805** | **-3** | **-6** | **3** |
| Balaka | 8 | 230 | 127 | 172 | -26 | -45 | 34 |
| Blantyre | 10 | 466 | 465 | 446 | 4 | 0 | 4 |
| Chikwawa | 4 | 414 | 435 | 700 | -38 | 5 | -41 |
| Chiradzulu | 7 | 455 | 417 | 1,017 | -59 | -8 | -55 |
| Machinga | 26 | 1,141 | 1,064 | 1,047 | 2 | -7 | 9 |
| Mangochi | 11 | 817 | 900 | 1,090 | -17 | 10 | -25 |
| Mulanje | 36 | 1,156 | 1,102 | 966 | 14 | -5 | 20 |
| Mwanza | 3 | 763 | 570 | 128 | 344 | -25 | 495 |
| Neno | 4 | 351 | 365 | 1,002 | -64 | 4 | -65 |
| Nsanje | 1 | 704 | 744 | 150 | 396 | 6 | 369 |
| Phalombe | 4 | 1,304 | 1,159 | 1,803 | -36 | -11 | -28 |
| Thyolo | 31 | 653 | 594 | 560 | 6 | -9 | 17 |
| Zomba | 15 | 714 | 691 | 669 | 3 | -3 | 7 |
| ***Total*** | ***381*** | ***789*** | ***735*** | ***922*** | ***-20*** | ***-7*** | ***-14*** |

**Table 36.** Discrepancies between mean areas from different measurement instruments by plot size

| | Total | GPS area | Tapearea | Self-report area | Tape vs. GPS error | GPS area vs. Self-reported error | Tape vs. Self-reported |
|---|---|---|---|---|---|---|---|
| *Plot size ($m^2$)*[z] | Obs. | ($m^2$) | ($m^2$) | ($m^2$) | (%) | (%) | (%) |
| Large (>2000) | 52 | 2,994 | 2,251 | 1,506 | 33 | 99 | 49 |
| Large low (1000-2000) | 53 | 1,366 | 1,443 | 1,343 | -5 | 2 | 7 |
| Medium high (800-1000) | 16 | 905 | 866 | 1,022 | 5 | -12 | -15 |
| Medium (500-800) | 50 | 653 | 697 | 909 | -6 | -28 | -23 |
| Medium low (200-500) | 110 | 331 | 370 | 675 | -11 | -51 | -45 |
| Small (100-200) | 55 | 151 | 185 | 674 | -18 | -78 | -73 |
| Very small (50-100) | 33 | 77 | 123 | 621 | -37 | -88 | -80 |
| Extremely small (<50) | 12 | 35 | 57 | 667 | -40 | -95 | -91 |
| ***Grand Total*** | ***381*** | ***2,994*** | ***2,251*** | ***1,506*** | ***33*** | ***99*** | ***49*** |

**Notes**: z based on GPS measurement. Total number of area measurement conducted for N=381. Self-reported area was obtained in the household survey.

## 8.3 Sweetpotato yield – based on crop-cuts

### Methodology

Crop-cut farmers /respondents were selected from all the dominant sweetpotato producing Agro-Ecological Zones (AEZs) with significant sweetpotato interventions over the period spanning the years targeted for the household study. Farmers were selected using multistage random sampling technique with AEZs as the primary units and Extension Planning Areas (EPAs), villages and household as secondary units. Out of the 14 AEZs, 12 were purposively selected, followed by purposive selection of EPAs. Villages and households were then randomly selected from OFSP beneficiary lists. The exercise covered areas in the Southern, Central, and Northern regions where sweetpotato is a major crop. Data were collected during the harvest period in April-May 2019. A representative sample of 768 farm households participated in the crop cut exercise. It targeted the OFSP varieties released in Malawi, variety Kenya, and a dominant local variety. The exercise adopted a simple method developed by CIP and partners in selecting the location of the area to be harvested in the farmers' sweetpotato plot. The method entails walking half-way down the longest side (length) of the plot and one-third down the shorter side (width), then measure an area of 3 meters by 2 meters (6 square meters). All the roots and vines in the area were harvested and weighed, and a formula used to calculate root yield.

### Sweetpotato yields based on crop-cuts

Table 37 presents the yields of OFSP, Kenya and dominant local variety obtained from the crop cut exercise by region. Table 9A in the Annex presents more detailed information about yield by AEZ. The overall average sweetpotato root yield was 8.8 tons/ha and varied significantly among the AEZs. Mount Mulanje and Zomba, Shire Highlands were the 2 AEZs with the highest mean yields of 11.7 and 10.6 tonnes per hectare, respectively. There was no statistical difference in root yield between OFSP and non-OFSP varieties (including Kenya). Comparison of the five improved OFSP varieties (excluding Zondeni) with non-OFSP varieties also found no statistical difference, with the mean yield for the five OFSP being 8.9 tons/ha

and non-OFSP varieties 9.3 tons/ha. Zondeni was excluded from this analysis because it is an old OFSP variety that, unlike the five more recently released varieties, was not a result of a breeding program but a local landrace. Among the OFSP varieties, Mathuthu had the highest yields of 11.7 tons/ha but was also relatively scarce to find in the communities during the study. The second-best yielding was from the Chipika variety with a mean yield of 9.4 tons/ha.

**Table 37.** Root yield of sweetpotato (tons/ha) in Malawi based on crop-cuts by region and variety

| | Regions | | | | p-value |
|---|---|---|---|---|---|
| Varieties | All | Northern | Central | Southern | |
| Anaakwanire | 8.6 [5.5] | -- | 10.9 [5.8] | 5.2 [3.1] | 0.05 |
| Kadyaubwerere | 7.9 [5.3] | 3.4 [5.3] | 7.2 [3.7] | 9.0 [5.7] | 0.01 |
| Kaphulira | 9.0 [6.0] | 6.6 [5.0] | 9.0 [4.7] | 9.6 [7.2] | 0.30 |
| Mathuthu | 11.7 [10.6] | 3.7 [0.9] | 14.4 [11.8] | 10.9 [10.2] | 0.40 |
| Zondeni | 7.1 [5.9] | 5.6 [6.5] | 8.2 [6.5] | 5.1 [4.0] | 0.20 |
| Kenya | 8.4 [5.9] | 5.6 [3.2] | 8.8 [6.5] | 8.4 [5.5] | 0.50 |
| Chipika | 9.4 [5.1] | 7.0 [4.3] | 9.2 [4.5] | 9.5 [5.3] | 0.80 |
| Non-OFSP (i.e., dominant local) | 9.8 [7.0] | 7.3 [7.0] | 8.9 [5.5] | 11.8 [7.8] | 0.01 |

**Notes**: numbers in brackets are standard deviations

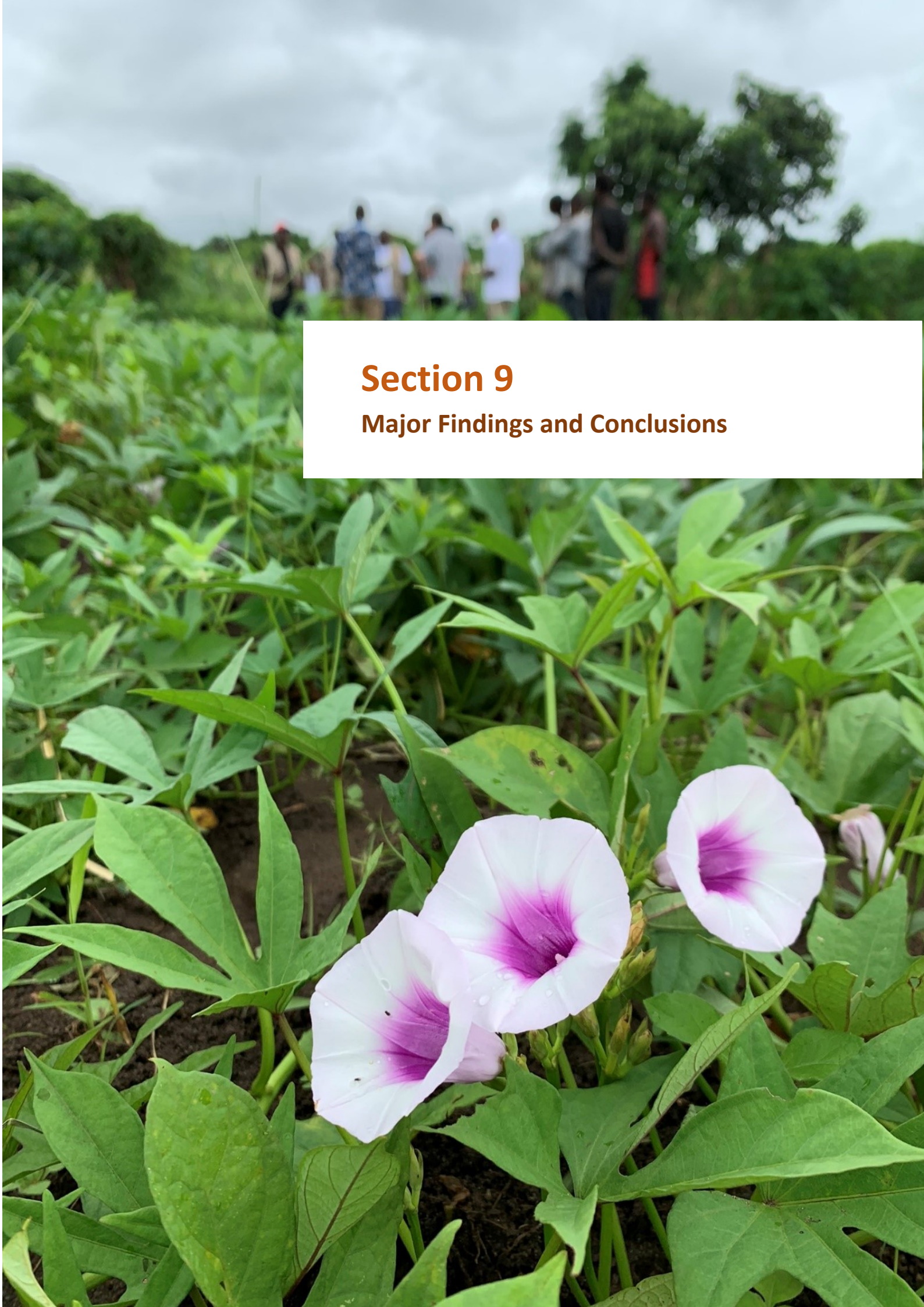
When grouped together, the non-OFSP varieties (excluding the yellow-fleshed Kenya) had an average mean yield of 9.3 tons/ha while the dominant Kenya variety had mean yield of 8.4 tons/ha. The OFSP landrace Zondeni variety had the smallest average yield of 7.1 tons/ha. These estimates are very similar to those obtained by van Vugt and Franke (2018) for these OFSP varieties under on-farm demonstration plots in Malawi.

### Data challenges and comparison with farmer-recall data

Some data collection challenges were encountered during the crop cut exercise. Ideally, a crop cut would be set up on farmer's fields at the beginning of the season and plots planted at approximately similar date. Because this was not possible, there was wide variation in planting dates, mainly due to different weather conditions in the different AEZs covered. The crop cuts were done in only one season and during roughly the same period (April/May). Therefore, there were some differences in level of maturity for some varieties/crops/plots during the time of the survey. This is particularly relevant for Zondeni, which is a late maturing (>6 months) variety. In addition, we were unable to meet the target sample size because plots with some of the OFSP varieties could not easily be found, especially Anaakwanire. Despite these challenges, our findings indicate that the 5 formally released OFSP varieties, in general, performed quite well and outperformed the local landrace OFSP variety Zondeni.

It was noted also that the yield estimates obtained from crop cuts (ranging from 8 tons/ha to 11 tons/ha) are not very different from the estimates based on farmer recall in Section 5 which averaged 11 tons/ha. Estimates based on crop-cuts from farmers' fields are generally considered more accurate than from farmer recall (Kilic et al, 2017; Lobell et al, 2018). This is supported by the fact that standard deviations are higher for yields calculated based on recall (Section 5) compared with yields measured using crop cuts. The yield estimates for OFSP by both recall and crop cut however fall much below the 32 tons/ha attainable yield reported by van Vugt (2018) for Malawi, but in practice only few farmers attain such yields. The study results are in line with the actual average sweetpotato yields of 5-9 tons/ha based on

the large number of variety demonstrations reported in the same study. Yields based on survey, crop cut, and harvest of on-farm demonstrations (van Vugt, 2018) all show a large variability which can be caused by many factors including planting date, rainfall, agro-ecological conditions, soil properties, pests and diseases and time of harvest. In farmer recall, additional variability may be introduced by errors in estimations of field area and quantities harvested by the farmers. In crop cuts, variability may have been introduced by harvesting crops of different level of maturity due to different planting times.



# Section 9

## Major Findings and Conclusions

# MAJOR FINDINGS AND CONCLUSIONS

This study addressed various research questions regarding the adoption and effects of nutritious OFSP varieties in Malawi. From the descriptive analysis of this study several findings and conclusions can be drawn which are presented in this section. More elaborate conclusions, especially regarding the identification of causal relationships are only possible with more rigorous statistical methods, for which this report intends to provide the basis.

Adoption rates of promoted OFSP varieties at least 2 years post OFSP distribution was higher for project participants (~66%) and non-participants (~48%) who lived in intervention villages, compared with the counterfactual households (~31%) who were not beneficiaries of OFSP interventions. This is remarkable considering that OFSP varieties were introduced only 10 years before in Malawi and reflects a high level of investment in their dissemination and good acceptance from beneficiaries. Similar adoption rates of participation in OFSP agriculture-nutrition interventions (61-68%) were found in Uganda (de Brauw et al., 2018).

Non-participants benefitted from OFSP interventions by receiving OFSP vines with a one-year time lag, after they were multiplied and disseminated in the same village by the original project beneficiaries. They were also indirectly exposed to other project-related activities, such as trainings, skits, cooking demonstrations, flyers, radio programs, etc. Rigorous statistical analyses will be conducted to examine which activities, and the extent to which these activities explain adoption by controlling for various household-level characteristics and regional differences.

Although in counterfactual villages adoption rates of OFSP varieties were lower, the fact that OFSP was still found in those villages is an important finding. These communities seemed to adopt varieties that were in general older than those promoted in intervention areas. It is possible that certain project activities (e.g., access to decentralized vine multipliers, listening to radio programs) spilled over to those counterfactual households, contributing to the observed OFSP adoption rates.

Given the observed spillover effect within the same communities, delivery models don't need to saturate communities to promote adoption, increasing cost-efficiency of interventions. Various forms of messaging about OFSP being a nutritious food may be strong enough to reach non-participants in the same community fast (~1 year when multiplied vines are available) and achieve wider adoption. The optimal level of saturation and cost-efficiency could be estimated with additional data and comparing with other countries.

Project and regional differences existed. First, adoption rates for participant and non-participant households were higher (~63%) in MISST project than in RTC-Action (~62%) and SUSTAIN (~57%) because MIIST project had extra extension agents located in every district supplementing the government extension network and used more intense demand-creation strategies such as songs and dramas highlighting the benefits of OFSP. Despite the statistical significance, differences were small, which point

to an overall success of OFSP interventions to contribute to sustainable adoption rates (i.e., at least 2 years post intervention). Strikingly, a significant 9-10% difference in adoption rates between MISST and RTC-Action/SUSTAIN was observed for non-participants only. Some project activities appeared to be more inclusive and contributing to more sustainable adoption behavior. Secondly, in the Southern region adoption rates were higher (~58%) than in the Central (~51%) and Northern regions (~49%). As the South received OFSP interventions earlier and over a longer period than the rest of the country, intervention intensity was a likely driver of the regional differences.

Malawian farmers had a rich diversity of sweetpotato varieties at their disposal. A total of more than 1,300 different variety names were reported in the survey. Despite the fact that various names were used for the same variety, overall, the high varietal richness was confirmed by the DNA fingerprinting exercise which found 175 different sweetpotato genotypes.

Among the OFSP varieties, Kadyaubwerere, Anaakwanire, and Chipika were the most frequently adopted OFSP varieties in 2019. Kenya remains the most frequently adopted non-OFSP variety, although half of the sample reported a decrease in area planted compared to 3 years ago. Similar share of respondents reported an increase in area planted to OFSP varieties, mostly substituting for non-OFSP varieties and maize. Jointly, these results are indicative of the declining importance of Kenya in areas where OFSP varieties were adopted. Average sweetpotato yields measured by crop cuts and farmer recall were about 9 tons/ha and 11 tons/ha, respectively, and significantly higher for project participants than non-participants and counterfactual respondents. Exposure to agronomic training and other project activities likely explain these differences.

The study found that frequency of consumption of vitamin A rich foods in general, and those from animal sources, was relatively high. Vitamin A consumption scores were higher for participant households compared to counterfactual households, and for the Northern and Central regions compared to the South. In addition, young children and caregivers within participant households consumed, on average, more diverse foods than non-participants and counterfactual households during the past 24 hours prior to the survey. However, majority of both the young children and caregivers did not attain the minimum recommended number of food groups for a healthy/quality diet. These findings imply that foods consumed by young children and caregivers were not adequate to supply the full micro and macronutrients needs of these household members.

Although market prices between OFSP varieties and Kenya did not differ, the small number of observations make the results only indicative. Some gender differences were observed with female sellers fetching significantly higher prices for OFSP, but not for Kenya, compared with their male counterparts. Possibly, women were more able to convince buyers of a premium to be paid for nutritious food. With caution, the study also observed higher market prices for OFSP in the South compared to the rest of the country, while observing the opposite pattern for Kenya: prices were the lowest in the South and highest in the North. Higher OFSP prices were strongly associated with higher intervention intensity which has possibly created demand and thus higher willingness to pay for nutritious food. In turn, increased nutritional awareness contributed to a reduced demand for less nutritious non-OFSP varieties, such as Kenya.

Regarding confirmation of varietal identity, it was found that farmers to a large extent misidentified the specific variety they were growing. However, nearly half of the respondents correctly identified OFSP varieties and OFSP promoted varieties, as a group, were under-reported just by 5%. Misidentification may have implications in the additional analysis to identify determinants of adoption of specific varieties, as more than half of the OFSP varieties were either positively or negatively misidentified.

This study is the first to estimate adoption of OFSP varieties in Malawi, after more than 10 years of dissemination investments from government and non-government organizations. The results are promising and show sustained adoption of OFSP across the country, with expected regional differences and across different types of adopting households. The data presented will help to address further research questions with more rigor and establish causality between results and explanatory variables. Results and information presented in this report can also be useful in adjusting the design of future OFSP dissemination investments and in identifying potential complementary policy interventions to address the larger issue of vitamin A deficiency in Malawi.

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# APPENDIX

**Table 1A.** List of released sweetpotato varieties in Malawi

| Variety Name | Color | Year of Release | Source | Comment |
|---|---|---|---|---|
| Kenya (SPN/O) | Cream | 1988 | Tanzania | |
| Lunyangwa | White | 1990 | Local bred | |
| Kakoma (TIS 3017) | White | 1994 | IITA | |
| Semusa (Cemsa 74-288) | White | 1999 | CIP | |
| Mugamba (Mogamba) | Cream | 1999 | CIP | |
| Tainoni (Tainon 57) | Purple/Orange | 1999 | AVRDC | |
| Salera (CIP1941 121) | Cream | 2002 | CIP | |
| Sakananthaka (LU96/303) | White | 2008 | OPV (Malawi | |
| Zondeni | Orange | 2009 | Local | |
| Kadyaubwerere | Orange | 2011 | CIP-NARS | |
| Mathuthu | Purple/Orange | 2011 | CIP-NARS | |
| Kaphulira | Purple/Orange | 2011 | CIP-NARS | |
| Chipika | Purple/Orange | 2011 | CIP-NARS | |
| Anaakwanire | Orange | 2011 | CIP-NARS | |
| Nyamoyo | Cream | 2011 | CIP-NARS | |
| Sungani | Cream | 2011 | CIP-NARS | |
| Royal choice (BV11/131) | Orange | 2018 | CIP-NARS | Not disseminated |
| Msungabanja (BV11/150A) | Orange | 2018 | CIP-NARS | Not disseminated |
| Nthetsanjala (BV11/172A) | Orange | 2018 | CIP-NARS | Not disseminated |

## **Appendix 2.** Theoretical framework for sample size calculation

(Based on Walker and Adam, 2011 for DIIVA project)[11]

The sample size and design are pivotal elements in the planning of any survey. The former determines a part of the survey cost, the number of sampling units, the number of data collectors to hire and their workloads, while the latter indicates how the sampling units will be selected and should seek a compromise between increased precision and reduced cost.

The sample size depends on the objectives of the survey and some design parameters. Usually the following parameters are considered: (i) the desired precision level; (ii) the variability of the main variable(s); (iii) the level of confidence; (iv) design effect and (v) the available resources to conduct the survey. In addition the coverage and response rates are also considered in some surveys to adjust the sample size and in impact assessment studies, the power of the test is also considered.

[11] Walker, T.; Adam, A. 2011. Guidelines for data collection for Objective 2 of the DIIVA Project.

As indicated above, clustering is one of the characteristics of the design to be used. The determination of sample size for a cluster sample involves five steps:

**Step 1: Determination of the intra class correlation**

An estimate of the intra class correlation may be obtained from previous surveys or from data of previous surveys. For the purpose of estimating the intra cluster correlation (rate of homogeneity) a two-stage random sampling is considered.

A first stage (primary) units denoted by α and B second stage units (elements0 per primary units, denoted by β.

The total variance can be decomposed into the among clusters (primary units) variance, and the within cluster variance

$$\frac{1}{AB}\sum_{\alpha}^{A}\sum_{\beta}^{B}\left(Y_{\alpha\beta}-\overline{Y}\right)^2=\frac{1}{A}\sum_{\alpha}^{A}\left(\overline{Y_{\alpha}}-\overline{Y}\right)^2+\frac{1}{AB}\sum_{\alpha}^{A}\sum_{\beta}^{B}\left(Y_{\alpha\beta}-\overline{Y_{\alpha}}\right)^2$$

**Step 2: Determination of the optimum cluster size (sub-sampling at the second stage)**

Let C be a simple cost model with $C=\alpha C_1 + \alpha\beta C_2$ , where C is the total cost of selecting a cluster (PSU) and HH within PSUs, C1 and C2 are respectively the cost of an additional cluster and the cost of and additional HH. Then the optimum number of HH to select at the second stage is given by:

$$b_{opt}=\sqrt{\frac{C_1}{C_2}\frac{(1-\rho)}{\rho}}$$

Given the information (previous survey as you indicated) at hand, you should be able to come up (estimate, guess, or assume) with good estimates of the above costs.

**Step 3: Determination of the Design Effect**

The design effect of a design δ for an estimator $\hat{\tau}$ is defined as the ratio of the variance of the estimator under the design δ and the variance of the estimator under a simple random sampling (srs) design

$$\text{Deff}(\delta, \hat{\tau}) = \frac{Var(\hat{\tau};\delta)}{Var(\hat{\tau};srs)}$$

With a cluster sampling the design effect depends on the sample size within PSUs and the intra class correlation and is given by Deff = 1 + (bopt – 1)ρ. The design effect for a cluster sample is usually greater one.

**Step 4: Sample Size for simple random sampling**

There are more than one approach to determine the sample size under simple random sampling: (i) confidence interval approach; (ii) specifying a desired precision (sampling variance of the estimated parameter i.e. the adoption rate $\hat{p}$ we want to achieve); and (iii) desired relative error as measured by the coefficient of variation of the parameter's estimate).

Let N and n be respectively the population and the sample sizes.

***(i) Confidence Interval Approach***

Under simple random sampling, if we wish to be 95% confident that the estimate adoption rate $\hat{p}$ be within l% of the true adoption rate p, then the sample size n must satisfy the formula:

$$n \geq \frac{z_{0.95}^2 NP(1-P)}{(N-1)l^2 + z_{0.95}^2 P(1-P)}$$

P varies from 0 to 1. For the purpose of determining n, we choose the value of P for which the quantity P(1-P) is maximal. This value is 0.5. Then the above formula with $z_{0;95}^2 = 1.95$ becomes

$$n \geq \frac{1.95^2 (0.25N)}{(N-1)l^2 + 1.95^2 (0.25)}$$

***(ii) Specifying a desired precision level $V^2$***

or $$V^2 = (1-f)\frac{S^2}{n} \quad \frac{S^2}{V^2}$$

Solving for n, we get $$n = \frac{n^*}{1 + n^*/N}$$

***(iii) Desired relative error*** $[CV(\hat{p})]$

or $$CV(\bar{y}) = \frac{\sqrt{(1-f)\frac{S^2}{n}}}{\hat{p}} \quad \frac{S^2}{V^2(\hat{p})}$$

We need to have an estimate of p. This can be obtained from previous surveys and/or data. In the absence of such information the value of p = 0.5 which gives the maximum value of $S^2$ = p(1-p) = 0.25 may be used. This will lead to a big value of n.

**Step 5: Final Sample Size**

Let sample size for the cluster sampling is obtained by multiplying the SRS sample size by the design effect. If the response rate is r and the coverage rate is c then the final sample size is

$$n_{cl} = \frac{nDeff}{rc}$$

Once the sample size is determined, the number of clusters (PSU) can be determined by dividing the sample size by the subsample size $b_{opt}$.

a = Number of PSUs = $n_{cl}/b_{opt}$

The available resources are the final determinant of the sample size. If the available resources are not sufficient for the specified precision level, then we need to revisit our targeted precision level and make it compliant with the available resources.

**Table 2A.** Parameters used and outcome of power calculation

| Parameters | Values |
|---|---|
| Total OFSP growing households (N) | 500,000 |
| z(0.95) | 1.96 |
| Estimated adoption level of OFSP (l) | 0.17 |
| Precision level of the (p) | 0.03 |
| Minimum sample size unadjusted | 602 |
| Intraclass correlation (ICC) | 0.30 |
| Cost of adding a village (US$) | 2,014.7 |
| Cost of adding a HH (US $) | 46,1 |
| Optimal cluster size (Bopt) | 11 |
| Design Effect (DEFF) | 4 |
| ***Final Sample Size*** | ***2,409*** |

**Table 3A.** Costs estimation for adding 1 additional household

| | |
|---|---|
| Enumerators<br>(3 questionnaire/day, 93 dollars/enumerator/day) | US$ 31 |
| Supervisors<br>(supervise 15 questionnaires/day, 216 dollars/day) | US$ 14.4 |
| Gasoline for cars<br>(15 surveys, 10 dollars for oil transportation inside the village) | US$ 0.7 |
| ***Total*** | ***US$ 46.1*** |

**Table 4A.** Costs estimation for adding 1 additional village

| | |
|---|---|
| Enumerators<br>(5 enumerators/villages) | US$ 465 |
| Supervisor<br>(216 dollars per day) | US$ 216 |
| Car rental per day<br>(1200 rental + 42 dollars for 35 liter of oil per day + 40 dollars for driver) | US$ 1,282 |
| Supplies<br>(Notebooks, pens, pencils, photocopy, etc) | US$ 45 |
| Mobilizers | US$ 6.7 |
| ***Total*** | ***US$ 2,014.7*** |

**Table 5A.** SP area, CIP-beneficiaries and sample of households by intervention group and district

| Districts | SP area in ha (14-15) | Prop. of total SP area | No. of CIP benef. | Prop. of benef. | Total sample | CIP partic. HHs | Non-partic. HHs | Counter-factual HHs | Leaf sample HHs |
|---|---|---|---|---|---|---|---|---|---|
| **Northern Region** | **27,041** | **0.11** | **3,871** | **0.09** | **285** | **143** | **52** | **90** | **52** |
| Chitipa | 7495 | | 205 | | 32 | 11 | 4 | 15 | 4 |
| Karonga | 2484 | | 247 | | 32 | 11 | 4 | 15 | 4 |
| Mzimba | 9866 | | 1826 | | 120 | 66 | 24 | 30 | 24 |
| Nhata Bay | 5606 | | 1007 | | 60 | 33 | 12 | 15 | 12 |
| Rumphi | 1590 | | 586 | | 45 | 22 | 8 | 15 | 8 |
| **Central Region** | **87,361** | **0.37** | **15,179** | **0.37** | **900** | **517** | **188** | **195** | **188** |
| Dedza | 8441 | | 2140 | | 135 | 77 | 28 | 30 | 28 |
| Dowa | 13467 | | 998 | | 60 | 33 | 12 | 15 | 12 |
| Kasungu | 10797 | | 256 | | 30 | 11 | 4 | 15 | 4 |
| Lilongwe | 26783 | | 1755 | | 90 | 55 | 20 | 15 | 20 |
| Mchinji | 9884 | | 1939 | | 120 | 66 | 24 | 30 | 24 |
| Nkhotakota | 3422 | | 1281 | | 75 | 44 | 16 | 15 | 16 |
| Ntcheu | 8863 | | 1934 | | 120 | 66 | 24 | 30 | 24 |
| Ntchisi | 3220 | | 915 | | 60 | 33 | 12 | 15 | 12 |
| Salima | 2484 | | 3961 | | 210 | 132 | 48 | 30 | 48 |
| **Southern Region** | **122,988** | **0.52** | **22,132** | **0.54** | **1,335** | **781** | **284** | **270** | **284** |
| Balaka | 2839 | | 1166 | | 75 | 44 | 16 | 15 | 16 |
| Blantyre | 5596 | | 1523 | | 90 | 55 | 20 | 15 | 20 |
| Chikwawa | 7637 | | 82 | | 30 | 11 | 4 | 15 | 4 |
| Chiradzulu | 4815 | | 518 | | 45 | 22 | 8 | 15 | 8 |
| Machinga | 5952 | | 7426 | | 420 | 264 | 96 | 60 | 96 |
| Mangochi | 14241 | | 1903 | | 120 | 66 | 24 | 30 | 24 |
| Mulanje | 22590 | | 3019 | | 150 | 99 | 36 | 15 | 36 |
| Mwanza | 3980 | | 261 | | 30 | 11 | 4 | 15 | 4 |
| Neno | 3372 | | 200 | | 30 | 11 | 4 | 15 | 4 |
| Nsanje | 5888 | | 282 | | 30 | 11 | 4 | 15 | 4 |
| Phalombe | 15013 | | 481 | | 30 | 11 | 4 | 15 | 4 |
| Thyolo | 13992 | | 3603 | | 195 | 121 | 44 | 30 | 44 |
| Zomba | 17073 | | 1668 | | 90 | 55 | 20 | 15 | 20 |
| ***Total*** | ***237,390*** | ***1*** | ***41,182*** | ***1*** | ***2,520*** | ***1,441*** | ***524*** | ***555*** | ***524*** |

**Notes**: Likoma district located on an island was excluded; for logistical purposes, number of households are sampled only in increments of 15 households and a minimum of 15 households per village. In some districts the number of households were brought down to a round number which can be divided by 15; in other cases, households were brought up; for sampled non-CIP households generally 1/3 of total sample are considered.

**Table 6A.** List of markets visited per region, date and presence of OFSP

| Interview date | District in South | OFSP in Market | Interview date | District in Central | OFSP in Market | Interview date | District in North | OFSP in North |
|---|---|---|---|---|---|---|---|---|
| June 06th | Blantyre | Yes | July 03rd | Ntcheu | Yes | July 17th | Mzimba | No |
| June 06th | Chiradzulu | Yes | July 04th | Dedza | No | July 21st | Nkhatabay | No |
| June 07th | Phalombe | Yes | July 04th | Ntcheu | No | July 23rd | Chitipa | Yes |
| June 10th | Mulanje | Yes | July 06th | Dedza | Yes | July 23rd | Karonga | Yes |
| June 18th | Chikwawa | No | July 09th | Dedza | Yes | July 24th | Rumphi | No |
| June 18th | Nsanje | No | July 09th | Dedza | Yes | | | |
| June 19th | Mwanza | No | July 10th | Salima | No | | | |
| June 19th | Thyolo | Yes | July 11th | Salima | No | | | |
| June 19th | Neno | Yes | July 13th | Salima | No | | | |
| June 21st | Zomba | Yes | July 13th | Mchinji | No | | | |
| June 25th | Mangochi | No | July 15th | Mchinji | Yes | | | |
| June 27th | Machinga | No | July 16th | Mchinji | Yes | | | |
| July 02nd | Balaka | No | July 25th | Nkhotakota | No | | | |
| | | | July 26th | Kasungu | No | | | |
| | | | July 29th | Ntchisi | No | | | |
| | | | July 29th | Ntchisi | No | | | |
| | | | July 29th | Dowa | No | | | |
| | | | July 30th | Lilongwe | Yes | | | |
| | | | July 30th | Lilongwe | No | | | |
| | | | July 31th | Lilongwe | No | | | |
| | | | July 31th | Lilongwe | No | | | |
| | | | July 31th | Lilongwe | No | | | |
| | | | August 02nd | Dedza | Yes | | | |

**Table 7A.** Adoption in 2019 by region and district

| | | Sweetpotato | OFSP | Participants | Non-participant | Counter-factual |
|---|---|---|---|---|---|---|
| | Obs | Mean | Mean | Mean | Mean | Mean |
| *North* | *284* | *0.96* | *0.49* | *0.61* | *0.41* | *0.34* |
| Chitipa | 30 | 1.00 | 0.27 | 0.36 | 0.25 | 0.20 |
| Karonga | 30 | 1.00 | 0.30 | 0.45 | 0.00 | 0.27 |
| Mzimba | 120 | 0.95 | 0.59 | 0.69 | 0.55 | 0.42 |
| Nhata Bay | 60 | 0.97 | 0.53 | 0.64 | 0.33 | 0.47 |
| Rumphi | 44 | 0.93 | 0.41 | 0.50 | 0.44 | 0.27 |
| *Central* | *949* | *0.88* | *0.51* | *0.61* | *0.46* | *0.30* |
| Dedza | 135 | 0.89 | 0.52 | 0.66 | 0.54 | 0.13 |
| Dowa | 60 | 0.85 | 0.48 | 0.50 | 0.31 | 0.60 |
| Kasungu | 30 | 0.93 | 0.53 | 0.64 | 0.00 | 0.60 |
| Lilongwe East | 45 | 0.78 | 0.51 | 0.55 | 0.42 | 0.00 |
| Lilongwe West | 60 | 0.95 | 0.62 | 0.73 | 0.58 | 0.40 |
| Mchinji | 135 | 0.85 | 0.55 | 0.59 | 0.62 | 0.37 |
| Nkhotakota | 75 | 0.91 | 0.41 | 0.47 | 0.41 | 0.27 |
| Ntcheu | 135 | 0.88 | 0.47 | 0.63 | 0.35 | 0.13 |
| Ntchisi | 49 | 0.89 | 0.33 | 0.46 | 0.38 | 0.07 |
| Salima | 225 | 0.89 | 0.57 | 0.66 | 0.46 | 0.37 |
| *South* | *1,259* | *0.89* | *0.58* | *0.70* | *0.51* | *0.30* |
| Balaka | 75 | 0.88 | 0.48 | 0.64 | 0.33 | 0.20 |
| Blantyre | 90 | 0.76 | 0.44 | 0.51 | 0.23 | 0.67 |
| Chikwawa | 30 | 1.00 | 0.47 | 0.90 | 0.40 | 0.20 |
| Chiradzulu | 45 | 0.76 | 0.49 | 0.62 | 0.33 | 0.40 |
| Machinga | 223 | 0.91 | 0.65 | 0.73 | 0.63 | 0.30 |
| Mangochi | 135 | 0.87 | 0.58 | 0.70 | 0.64 | 0.20 |
| Mulanje | 195 | 0.91 | 0.67 | 0.68 | 0.63 | 0.67 |
| Mwanza | 15 | 1.00 | 0.73 | 0.91 | 0.25 | 0.00 |
| Neno | 45 | 0.93 | 0.33 | 0.91 | 0.50 | 0.10 |
| Nsanje | 30 | 0.97 | 0.37 | 0.75 | 0.43 | 0.13 |
| Phalombe | 46 | 0.78 | 0.41 | 0.63 | 0.33 | 0.20 |
| Thyolo | 225 | 0.93 | 0.66 | 0.74 | 0.60 | 0.40 |
| Zomba | 105 | 0.89 | 0.55 | 0.72 | 0.39 | 0.07 |

**Table 8A.** Reasons for not planting sweetpotato in 2019

| | Total | OFSP | Yellow | White/cream |
|---|---|---|---|---|
| Reasons | **Mean** | **Mean** | **Mean** | **Mean** |
| Varietal traits/characteristics | 0.23 | 0.17 | 0.23 | 0.29 |
| Low root yield | 0.13 | 0.09 | 0.13 | 0.18 |
| Takes too long to mature | 0.02 | 0.01 | 0.03 | 0.03 |
| Susceptible to pests | 0.01 | 0.01 | 0.01 | 0.01 |
| Susceptible to disease | 0.01 | 0.01 | 0.01 | 0.01 |
| Too watery | 0.00 | 0.00 | 0.00 | 0.01 |
| Bad taste | 0.01 | 0.00 | 0.01 | 0.01 |
| Not drought resistant | 0.03 | 0.04 | 0.02 | 0.01 |
| Not marketable | 0.02 | 0.01 | 0.02 | 0.02 |
| Access/availability of planting material | 0.37 | 0.45 | 0.37 | 0.27 |
| Lack of planting material | 0.15 | 0.18 | 0.16 | 0.12 |
| Difficult to find planting material | 0.13 | 0.15 | 0.15 | 0.10 |
| Difficult to maintain/keep vines | 0.08 | 0.12 | 0.06 | 0.05 |
| Resource constraints | 0.07 | 0.06 | 0.09 | 0.07 |
| Lack of access to land | 0.06 | 0.06 | 0.07 | 0.06 |
| Lack of finance | 0.01 | 0.01 | 0.02 | 0.02 |
| Farmer choices | 0.14 | 0.08 | 0.16 | 0.22 |
| Opted for new SP variety | 0.10 | 0.05 | 0.11 | 0.15 |
| Waiting for winter season | 0.05 | 0.03 | 0.05 | 0.07 |
| Beyond farmer control | 0.13 | 0.18 | 0.11 | 0.10 |
| Farmer sick | 0.04 | 0.05 | 0.04 | 0.03 |
| Floods/Heavy Rains | 0.03 | 0.03 | 0.02 | 0.02 |
| Vines destroyed by livestock/animals | 0.07 | 0.10 | 0.05 | 0.04 |
| Other | 0.05 | 0.05 | 0.05 | 0.05 |

**Table 9A.** Mean Sweetpotato Root Yield (tons/ha) in Malawi using Crop Cut in 2019. Data in brackets represent standard deviations from the mean

| Parameters | Agro-Ecological Zones (AEZs) | | | | | | | | | | | | | P-Value[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | Chilwa Plain, Mchinji, Kasungu | Chintheche, Chikwangawa, Wenya | Dowa Hills | Lilongwe East, Misuku | Lilongwe Plain | Mount Mulanje | Mulanje, Karonga North | Namwera | Nkhamenya, Kasungu, Mchinji Plain | Nkhatabay, Mzuzu | Upper Shire | Zomba Shire Highlands | |
| Overall Yield (t/ha) | 8.8 [6.3] | 9.3 [6.6] | 6.6 [6.9] | 8.1 [5.6] | 6.9 [3.9] | 9.9 [6.3] | 11.7 [7.6] | 9.0 [5.9] | 8.7 [7.7] | 9.0 [6.2] | 5.9 [4.7] | 7.9 [5.5] | 10.6 [6.4] | 0.0001 |
| OFSP varieties (all) | 8.7 [6.1] | 9.6 [6.0] | 3.1 [3.0] | 7.3 [5.4] | 7.0 [3.0] | 10.3 [7.1] | 11.6 [7.6] | 9.4 [6.9] | 9.0 [7.6] | 8.5 [5.4] | 6.5 [5.4] | 7.6 [4.3] | 9.4 [5.8] | |
| Improved OFSP varieties | 8.9 [6.1] | 10.7 [6.4] | 3.2 [3.2] | 8.6 [5.7] | 6.9 [2.8] | 10.0 [6.8] | 11.6 [7.6] | 9.6 [7.0] | 9.0 [7.6] | 8.3 [4.3] | 6.4 [5.3] | 7.7 [4.2] | 9.7 [5.8] | |
| Non-OFSP varieties | 9.3 [6.6] | 8.8 [7.6] | 8.3 [7.6] | 9.5 [5.8] | 7.6 [4.5] | 9.3 [4.6] | 12.5 [7.4] | 8.2 [3.9] | 8.1 [8.1] | 9.6 [7.0] | 4.8 [3.0] | 9.2 [8.7] | 12.5 [7.1] | |
| Individual Varieties | | | | | | | | | | | | | | |
| *Anaakwanire* | 8.6 [5.5] | 15.3 [4.0] | -- | -- | -- | 11.5 [6.8] | 4.7 [.] | 7.3 [0.3] | 4.0 [4.2] | 5.7 [0.9] | -- | -- | -- | |
| *Kadyaubwerere* | 7.9 [5.3] | 8.2 [5.4] | 0.7 [0.3] | 9.1 [6.8] | 5.8 [3.0] | 7.2 [1.5] | 9.5 [4.1] | 13.4 [10.0] | 7.0 [3.0] | 10.0 [4.6] | 5.0 [6.4] | 7.0 [4.0] | 9.4 [4.4] | |
| *Kaphulira* | 9.0 [6.0] | 12.0 [7.5] | 2.6 [2.0] | 10.2 [5.0] | 7.8 [2.8] | 8.9 [3.9] | 12.5 [10.4] | 8.5 [6.5] | 7.5 [3.2] | 8.0 [4.1] | 7.3 [5.1] | 6.4 [3.5] | 11.5 [8.4] | |
| *Mathuthu* | 11.7 [10.6] | 9.2 [7.9] | 4.3 [.] | -- | 9.0 [.] | 24.4 [15.8] | -- | 2.7 [.] | 19.2 [16.2] | 9.8 [7.6] | 3.1 [.] | 8.8 [4.4] | 5.3 [.] | 0.04 |
| *Zondeni* | 7.1 [5.8] | 6.2 [3.1] | 2.2 [.] | 4.9 [4.1] | 7.1 [3.8] | 11.9 [9.3] | -- | 5.7 [1.6] | -- | 9.0 [9.6] | 7.3 [8.2] | 1.4 [.] | 6.7 [5.5] | |
| *Kenya* | 8.4 [5.9] | 8.2 [7.8] | 7.0 [1.4] | 11.3 [3.9] | 5.5 [3.8] | 9.9 [4.4] | 6.9 [2.8] | 7.5 [4.1] | 5.8 [1.7] | 10.2 [8.4] | 4.6 [4.1] | 1.2 [0.2] | 11.7 [8.2] | |
| *Chipika* | 9.4 [5.1] | 10.8 [6.9] | 7.0 [4.3] | 3.2 [2.6] | 7.6 [2.0] | -- | 13.0 [4.6] | 8.8 [4.5] | 10.8 [8.2] | 11.2 [.] | -- | 9.5 [4.9] | 8.3 [2.9] | |
| Non-OFSP | 9.8 [7.0] | 9.4 [7.8] | 8.4 [8.0] | 7.8 [7.2] | 8.7 [4.6] | 8.7 [5.0] | 16.1 [7.2] | 9.2 [3.8] | 9.8 [10.6] | 9.0 [5.2] | 4.9 [2.8] | 10.7 [8.6] | [5.7] | |

# SUPPLEMENTARY MATERIAL

## **Supplementary Material A** – Household-level Survey Instrument

**International Potato Center**

**Adoption and Effects of Improved Sweetpotato Varieties in Malawi**

**Household Survey Questionnaire**

**Training version 10**

**August 12, 2019**

## INFORMED CONSENT STATEMENT

Hello. My name is_____. I am working with International Potato Center on a study being conducted about farmer adoption and utilization of orange-fleshed sweet potato and its effects on household welfare. I would like to ask you general questions related to your household's sweetpotato production, consumption of sweetpotato and other foods, income from sweetpotato and other sources, and farming assets you have. The information you provide will be used to complement information provided by other farmers for documenting patterns of sweet potato production, importance of sweet potato and other nutritional foods in Malawi and identifying factors that influence sweetpotato production. Your participation in this research is voluntary and the information we get from you will be treated confidentially. It will be reported after being aggregated with those of others and your name and contacts or that of your family will not be specifically identified/mentioned in the report. Hence, your privacy and rights will be protected to the maximum extent allowable by law. The findings of this study will help us and our partners, including the [district] government, with which we collaborate, better understand the current issues in sweetpotato production.

You can choose to refuse to answer any questions and are free to withdraw from further participation in this interview at any time. In case you decline/withdraw, your lack of participation will not have any negative consequence on you, nor will it prevent you from benefitting from the future activities undertaken by CIP and its implementing partners including the government to improve sweetpotato industry. We would, however, appreciate your participation and completion of the interview, and your honest answers to the issues we shall discuss. During the course of the interview, we will also take some leaf samples of the sweetpotato you planted this season and also some pictures to learn more about the varieties you grow. You can however decline to have sweetpotato leaves and pictures taken without any penalty whatsoever.

The interview will take approximately **2 hours**. But before I continue do you have any questions about this research?

***[Enumerator: pause and respond to any questions raised, then continue with the following statement and inform the farmer that a YES means informed consent]***

In case you have any questions or concerns about this research afterwards, you can call my Supervisor [Norman/Zephaniah] on Tel …… or the Country Manager Dr. Daniel van Vugt on Tel 0999678889

With your permission/consent, I would like to start the interview. May I now proceed to start the interview? **YES**…… **NO**……

## PART 0. INTERVIEW BACKGROUND

**Farmer and site identification**

1a. Enumerator

*(11. Alice Banda, 12. Alinafe Kachiguma, 13. Alinafe Kananji, 14. Andrew Mgemezulu, 16. Charles Ezekiel Kashamba, 17. Chimwemwe Ntambalika, 18. Chisomo Kaphuka, 19. Doreen Nkhata, 45. Edna Sibale, 20. Fiskani Nyirenda, 25. Isabel Dzimbiri, 26. Joseph Chipeta, 30. Kitty E. Maguja, 31. Laurent Banda, 34. Mary Ng'oma, 36. Petronella Kasinja, 37. Ramadhan Kadam'manja, 39. Samson Muthema, 40. Sharon Ulaya, 41. Vincent Mdothi, 44. Yamikani M. Jere)*

1b. Name of supervisor …… (*81. Norman Kwikiriza, 82. Zephania Nyirenda)*

1c. Name of team leader …… *(23. Grey Mutiye, 28. Kellen Kayange, 33. Madalitso Nkhata, 42. Wesley Dick Chikoko)*

1d. Date of interview [DD-MM-YYY]

1e. Start time (HH:MM:SS)

| | Question | Response |
|---|---|---|
| **2** | District | Name:_____ |
| **3** | EPA | Name:_____ |
| **4** | Section | Name _____ |
| **5** | Village | Name_____ |
| **6** | Latitude of the dwelling unit (in decimal degrees) | \|___\|___\|: North _\|___\|___\| |
| **7** | Longitude of the dwelling unit (in decimal degrees) | \|___\|___\|: East _\|___\|___\| |
| **8** | Altitude of the dwelling unit (MASL) | \|___\|___\|___\|___\| meters |

9. Name of respondent in full_____

10. Respondent is *(1-CIP project participant 2-Non-participant 3-Counterfactual)*

11. Telephone number of respondent/nearest neighbor/family member _____

**SCREENING QUESTIONS**

12. Have you **ever** grown sweetpotato 1=yes 0=no

13. Have you **ever** grown orange-fleshed sweetpotato 1=yes 0=no

14. Have you **ever** received orange-fleshed sweetpotato either from any organization or project? 1=yes 0=no

15. Which organization(s) did you receive vines from? [*Select from partner codes*].....

*(1. CIP, 2. CADECOM, 3. AGORA, 4. CARE, 5. Concern Worldwide, 6. Eagles, 7. Evangelicals, 8. FAO, 9. Feed the future, 10. Government, 11. Kasindura Farm growers, 12. LIPO Africa, 13. MOSECO, 14. Ripple effect, 15. Save The Children, 16. United purpose, 17. Action Against Hunger, 18. ADRA, 19. Africare, 20. DAPP, 21. HEALTH AFRICA, 22. NASFAM, 23. Oxfam, 24. WFP- World Food Program, 77. Do not Remember, 97. Other (specify))*

**DISTANCE QUESTIONS:** *[Enumerator note: Distance is measured from homestead. 77=Don't know;99=N/A]*

16. Distance to nearest market center (walking minutes)____

17. Distance to nearest all-weather road (walking minutes)_____

18. Distance to nearest public health facility (walking minutes) _____

19. Distance to the nearest home of the community health Surveillance assistants (walking minutes)_____

20. Distance to nearest orange-fleshed sweetpotato vine multiplier (walking minutes)_____

21. Distance to nearest government extension officer (walking minutes)_____

## PART A: CURRENT HOUSEHOLD COMPOSITION AND CHARACTERISTICS

**I would like to start by asking you questions relating to your household.**

**[***A household comprises man, wife, children and other people who live and eat together from the same pot for at least 6 months including the school going children and children less than one year***]**

**1.** How many people do live in this household? _____

**2.** Household member demographics

| 2.1. Member id | 2.2. Name of household members living in this household in 2019 [*start with head and followed by spouse*] | 2.3. Sex **Codes A** | 2.4. Relation to HH Head **Codes B** | 2.5. Age (years | 2.6. Marital status **Codes C** | 2.7. Formal Education | | 2.8. Can read/write? **Codes E** | 2.9. Main occupation **Codes F** | 2.10. Secondary occupation **Codes F** | 2.11. Is […] pregnant or breastfeeding? 0. No 1. Yes | 2.12. Is […] disabled ? 0. No 1. Yes | 2.13. Degree of participation in sweetpotato production **Codes G** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Level **Codes D** | Total Years completed | | | | | | |
| 1 | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |

| **Codes A** | **Codes B** | **Codes C** | **Codes D** | **Codes E** | **Codes F** | **Codes G** |
|---|---|---|---|---|---|---|
| 0.Female | 1. Household head | 1. Married living with spouse | 0. None | 0. No | 0. None | 1-Fully |
| 1. Male | 2. Spouse | 2. Married but spouse away | 1.Primary | 1. Yes | 1. Farming (crop + livestock) | 2-Partially |
| | 3. Son/daughter | 3. Divorced/separated | 2.Secondary Junior | | 2. Salaried employment | 3-No participation |
| | 4. Parent | 4. Widow/widower | 3. Secondary Senior | | 3. Self-employed off-farm | |
| | 5. Brother/sister | 5. Never married | 4. Tertiary | | 4. Casual labourer on-farm | |
| | 6. Son/daughter in-law | | 5. Adult education | | 5. Casual labourer off-farm | |
| | 7. Grand child | | | | 6. School/college child | |
| | 8. Other relative | | | | 7. Household chores | |
| | 9. Hired worker | | | | 8. Handcraft/weaving/basket | |
| | 10. Friend | | | | 97. Other (specify) | |
| | 97. Other (specify) | | | | | |

## PART B: SWEETPOTATO VARIETY KNOWLEDGE AND ADOPTION

### Section I: Sweetpotato variety knowledge, adoption and dis-adoption

Please select all sweetpotato varieties you have ever heard of. [*Use Codes for variety list*] _____

1. Zondeni 2. Anaakwanire 3. Kaphulira 4. Mathuthu 5. Kadyaubwerere 6. Chipika 7. Kenya 8. . Babache 9. Chikupha 10. Chinese 11. Folida 12. Hybrid 13. John 14. Kachikhula 15. Kamchiputu 16. Kampalendo 17. Kangazani 18. Mugamba 19. Namojoni 20. Nsanje 21. Nyamoyo 22. Research 23. Salera 24. Semusa 25. Gwentha 97. Other (specify

| | 1. Name of sweetpotato varieties aware/heard of [*Use variety codes* ] | 2. Flesh colour of the variety 1. Orange 2. Yellow 3. White/ Cream 4. Purple 77. Don't know 97. Other (specify) | 3. Year variety known/ heard of? **YYYY** | 4. Do you consider this variety*:* 1. Ancestral/local 2. Introduced 77. Don't know | 5. Ever planted? 0. No 1.Yes | 6. Year first planted **YYYY** | 7. Where did you obtain vines of this variety? **Codes A** | 8. Last year planted **YYYY 7777- Don't know** | 8a. If 2018, which season? 1-Rainfed 2-winter/dry | 9. If not planted in 2019, what was the **main** reason? **Code B** | 10. What land have you used to grow this variety. [Prompt: *Select all that apply*] **Codes C** | 11. Did you share vines of this variety with other farmers? 0-No; 1-Yes | 12. If YES, the vines were shared with ---. [*Select all that apply*] **Codes D** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Codes A** | 5. Government officer | **Codes B** | 7. Not drought resistant | **Codes C** | 5. Land on gazetted forestlands | **Codes D** | 5. Teenage boy/girl |
| 1. Farmer in same village | 6. CIP project | 1. Low root yield | 8. Not marketable | 1. Roadside land / Road reserve | 6. Prohibited area from the river/lake | 1. Women with children under 5 years | 6. Woman not in the |
| | 7. Bought at market | | 9. Lack of planting material | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2. Farmer in another village<br>3. Trained vine multiplier<br>4. NGO/CIP partner | 8. Bought from commercial farmer<br>9. Farmer field schools<br>10. Processors<br>97-Other (specify) | 2. Takes too long to mature<br>3. Susceptible to pests<br>4.Susceptible to disease<br>5. Too watery<br>6. Bad taste | 10. Difficult to find vines<br>11. Difficult to maintain/keep vines<br>12. Lack of access to land<br>13. Farmer was Sick<br>14. Lack of Finance<br>15. Floods/Heavy Rains<br>16. Opted for new sweetpotato varieties<br>17. Vines destroyed by Livestock<br>18. Waiting for Winter season<br>97. Other (specify) | 2. Land belonging to school, hospital, government offices<br>3. Land belong to the national park<br>4. Land on the hillside | 7. Arable land<br>8. Dambo/Lowlands<br>97. Other (specify) | 2. Pregnant women<br>3. Breastfeeding women<br>4. Disabled woman/man | above category<br>7. Man not in the above category |

13. Looking at all the area under sweetpotato during this year (2019) compared to 3 years ago, has the area: (*1. Increased 2. Decreased 3. Stayed the same 4. Started growing after 2016)*

14. Looking at all the area under **variety Kenya** in the **most recent** season of 2018 and 2019 compared to 3 years ago, has the area: *(1. Increased 2. Decreased 3. Stayed the same 4=Started growing after 2016)*

15. What was the size of your first ever orange-fleshed sweetpotato plot? 14a. Area …. 14b. Unit……. *[Codes: 1-acres 2-square metre 3-yards 4-hectares 97-Other (specify)]*

16. Compared to **year you first planted orange-fleshed sweetpotato** has the area under most recent orange-fleshed sweetpotato crop: *(1. Increased 2. Decreased 3. Stayed the same 4. Started growing after 2016)*

17. For which varieties of orange-fleshed sweetpotato have you expanded acreage (area planted) since first planting. [*Choose all that apply*] *1. Zondeni 2. Anaakwanire 3. Kaphulira 4. Mathuthu 5. Kadyaubwerere 6. Chipika 99. N/A*

18. If area under orange-fleshed sweetpotato variety(ies) has increased, which crop are you now growing less of due to increased production of the orange-fleshed sweetpotato variety(ies)? [*Use 99-N/A if orange-fleshed sweetpotato is not grown by the respondent*]

*(1. Maize, 2. Cassava, 3. Beans, 4. Groundnuts, 5. Pigeonpea, 6. Soyabean, 7. Non-OFSP sweetpotato varieties, 8. Sorghum, 9. Tobacco, 97. Other (specify), 99. Not Applicable*

19. What is the name of your **most** preferred sweetpotato variety?

*(1. Zondeni, 2. Anaakwanire, 3. Kaphulira, 4. Mathuthu, 5. Kadyaubwerere, 6. Chipika, 990. Other OFSP Variety, 7. Kenya (Vision, Admarc, 41, Boma, Research, Hybrid, Kasungu, Kenya mtuwa kuwalo, kenya yellow), 8. Babache, 9. Chikupha, 10. Chinese, 11. Folida, 12. Gwentha, 13. John, 14. Kachikhula, 15. Kamchiputu, 16. Kampalendo, 17. Kangazani, 18. Mugamba, 19. Namojoni, 20. Nsanje, 21. Nyamoyo, 22. Selera, 23. Semusa, 24. Bulenga, 25. CADECOM, 26. Catcom, 27. Chikhutu, 28. Chisilu, 29. Kaulesi, 30. Lifeboy, 31. Mangochi, 32. Sakananthaka, 991. Other (specify1))*

20. What is the name of your **most** preferred orange-fleshed sweetpotato variety?

*1. Zondeni 2. Anaakwanire 3. Kaphulira 4. Mathuthu 5. Kadyaubwerere 6. Chipika 7. Other orange-fleshed sweetpotato variety…. 97. Other specify)*

**Section II: Characteristics of the main sweetpotato varieties planted during the most recent season in 2018 or 2019**

*1. Ask the respondent how important the following characteristics were in the choice of **sweet potato** varieties planted in the **most recent** season of 2018 or 2019. Use **Codes A.***
*2. Ask the respondent to list the sweetpotato varieties grown in the most recent season. Then ask how each variety planted performed against these attributes using **Codes B.***

| Variety codes | | Characteristics | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Agronomic | | | | | | Economic/Market | | | | | Cooking & utilization | | | | |
| | | Root yield | Vine yield | Easy to keep vines (i.e., ease of vine availability) | Drought tolerance | Resistant to sweetpotato weevil | Virus (disease) tolerance | Early maturity | High dry matter (not watery) | Flesh colour | Marketability (demand) | Output (root) price | Storability after harvest | Taste | Nutritional value | Use of leaves as vegetable | Other (specify)… |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 97 |
| | 1. How important is this characteristic in your choice of a sweetpotato variety when deciding what to plant? **Codes A** | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | List the varieties | 2. How well did the sweetpotato varieties grown during the most recent season of 2018 or 2019 perform against these criteria? **Codes B** | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | |

| **Codes A** | **Codes B:** |
|---|---|
| Rank using *(1. Completely/very-unimportant 2. Unimportant 3. Neither unimportant nor important 4. Important 5. Very important 77. Don't know)* | Rank using*: (1. Extremely Poor 2. Poor 3. Neither poor nor good 4. Good 5. Extremely good/Excellent 77. Don't know)* |

## PART C: SWEETPOTATO PRODUCTION AND UTILIZATION

### Section I. Land holdings

| QUESTIONS | | | | Quantity | | Unit (Codes A) | | 6. Who makes decisions on how much land is used for sweetpotato production? |
|---|---|---|---|---|---|---|---|---|
| 1. Total amount of land holdings owned | | | | | | | | |
| 2a. Total amount of land **under sweetpotato** in most recent season of 2018 or 2019 | | 3a. Quantity/area owned | 3b Unit Codes A | 4a. Quantity/area Rented in | 4b. Unit Codes A | 5a Quantity/area borrowed | 5b Unit **Codes A** | 0-Female 1-Male 2-Both |
| Area | 2b. Units (Codes A) | | | | | | | |
| | | | | | | | | |

**Codes A**: 1. Acres 2. Square Meters 3. Square Yards 4. Hectares 97-Other

| | QUESTION | | ANSWERS |
|---|---|---|---|
| 7 | Do you have access to swamp land for farming | 0. No; 1. Yes | |
| 8 | How far is the nearest swampland from your homestead? *(In walking minutes)* | | |
| 9 | Do you do sweetpotato vine conservation (i.e., conserving vines for next planting season). | 0. No; 1. Yes | |
| 10 | If Yes, have you ever used Triple S? | 0-N0 1-Yes | |
| 11 | If Triple S has been used, who used it? | 0-Female 1-Male 2-Both | |

**Section II. Plot level production and utilization**

| | | Now, we would like to ask about your **most recent** sweetpotato crop that you planted and harvested. We will ask questions for each plot you had. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Plot number | 2. Plot name | 2a). Season 1-Rainfed 2019 2-Winter/dry 2018 | 3. Location of the plot 1. Uplands 2. Lowlands 97. Other (specify) | 4. Distance to the plot in walking minutes | 5. Area of the plot | 6. Area units 1-acres 2-square metre 3-yards 4-hectares 97-Other (specify)] | 7a. Was plot irrigated to supplement rain? 0. No 1. Yes | 7b. Was fertilizer used in this plot? 0. No 1. Yes | 7c Was pesticides applied in this plot? 0. No 1. Yes | 8. Was sweetpotato inter-cropped? 0. No 1. Yes | 9. If inter-cropped, what was the **main** crop? 1. Maize 2. Cassava 3. Beans 4. Groundnut 5. Pigeonpea 6. Soyabean 7. Peas 8. Pumkin 9. Rice 10. Sorghum 11. Sunflower 12. Tomatoes 13. Vegetables 97. Other (specify) | 10. If intercropped the proportion of sweetpotato in the crop? 1. Less than one-quarter (25%) 2. One-Quarter 3. Half 4. Three-quarter 5. More than three-quarter 6. Almost all | 11.Proportion of sweetpotato crop harvested 0. None 1. Less than one-quarter (25%) 2. One-Quarter 3. Half 4. Three-quarter 5. More than three-quarter 6. Almost all 7. All |
| | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | |

| **12.** Plot had Kaphulira? 0. No 1. Yes 77=Don't know | **13.**Proportion of Kaphurira | **14.** Plot had Zondeni? 0. No 1. Yes 77=Don't know | **15.** Proportion of Zondeni | **16.** Plot had Kadyau-bwerere? 0. No 1. Yes 77=Don't know | **17.** Proportion of Kadyau-bwerere | **18.** Plot had Chipika? 0. No 1. Yes 77=Don't know | **19.** Proportion of Chipika | **20.** Plot had Ana-kwanire? 0. No 1. Yes 77=Don't know | **21.** Proportion of Ana-kwanire | **22.** Plot had Mathuthu? 0. No 1. Yes 77=Don't know | **23.** Proportion of Mathuthu | **24.** Plot had Kenya? 0. No 1. Yes 77=Don't know | **25.** Proportion of Kenya | **26.** Plot had Other varieties? 0. No 1. Yes 77=Don't know | **27.** Proportion of other varieties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Proportion codes**: 1. Less than one-quarter (25%) 2. One-Quarter 3. Half 4. Three-quarter 5. More than three-quarter 6. Almost all 7-All

*…. Continuation from previous table….*

| Plot # | 28. Who manages the plot?<br>0. Female, 1. Male, 2. Both | 29. Is any of the managers less than 25 years old?<br>0. No, 1. Yes | 30. The land is……<br>1. Own, 2. Rent, 3. Borrowed for part of the crop (sharecropping), 4. Borrow for free | 31. What is the main sweetpotato product on this plot? 1. Roots. 2. Vines, 3. Both |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

| Plot # | 32. During which months did you do land preparation? | 33. During which months did you do planting? | 34. During which months did you do weeding/hilling up? | 35. During which months did you do piece-meal harvest only? | 36. During which months did you do main harvesting? |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |

**Codes for Months:**

*1. January, 2. February, 3. March, 4. April, 5. May, 6. June, 7. July, 8. August, 9. September, 10. October, 11. November, 12. December, 99. Did not carry out the activity*

| Plot number | During the main harvest months: The months of MAIN harvest were ---------- [*select as appropriate*: Jan, Feb, Mar, ….., Dec] | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **37a** | **37b** | **38a** | **38b** | **39** | **40a** | **40b** | **40c** | **41** | **42** | **43** | **44a** | **44b** | **44c** | **45** | **46** | **47** | **48** |
| | How much did you harvest in total in large amounts? | | How much of this large amount did you sell or pay in-kind for labor? | | Did you also harvest in small amounts for home consumption? | If Yes, during the Main Harvest period, think of how much you harvested during a typical week. How many <u>days</u> during that week did you harvest? What <u>amount per day</u>? | | | What proportion of this was sold or used as payment in-kind, if any? | What proportion of this was given out as gifts, if any? | Total revenues earned during main harvest months | Think of a typical month. Then think of a typical week in this period. How many <u>days</u> during that week did you harvest? What <u>amount per day</u>? | | | Did you sell any roots? | If Yes, what proportion was sold or used as payment in-kind, if any? | What proportion of this was given out as gifts, if any? | Total Revenues earned during minor harvest months |
| | Amount | Unit code | Amount | Unit code | 0. No 1. Yes | Days | Amount | Unit code | Code proportion | Code proportion | MK | Days | Amount | Unit | 0. No 1. Yes | Code proportion | Code proportion | MK |
| 1 | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | |
| **Codes:** | | | | | | | | | | | | | | | | | | |
| **Proportion code** | *0. None 1. Less than one-quarter (25%) 2. One-Quarter 3. Half 4. Three-quarter 5. More than three-quarter 6. Almost all* | | | | | | | | | | | | | | | | | |
| **Units** | *1-Kg; 2-100 Kg Maize Equiv. Bag; 3-90 Kg Maize Equiv. Bag; 4- 70 Kgs Maize Equiv. Bag; 5-50 Kg Maize Equiv. Bag; 6-10 Kg Maize Equiv. Bag; 7-10 Ltr Can; 8-Tons; 9-Ox Cart; 10- Chidebe; 11- Small basin; 12-Big basin; 97-Other-Specify* | | | | | | | | | | | | | | | | | |

| | |
|---|---|
| **49** | **If OFSP and white/yellow fleshed sweetpotato were sold:** For the same quantity (i.e., pile size) sold, does orange-fleshed sweetpotato get a higher, lower, or same price as white/yellow-fleshed sweetpotato? 1. Higher; 2. Lower; 3. Same |
| **50** | **If any sweetpotato was sold,** who made decision on how much was sold? 0-Female 1-Male 2-Both |
| **51** | **If any sweetpotato was sold,** who made decision on how revenue earned was used? 0-Female 1-Male 2-Both |
| **52** | **If any sweetpotato was sold,** where was your major point of sale? 1. At the field; 2. Local market; 3. Distant market; 4. Deliver to agro-processor; 5. Deliver directly to other client(s); 6. Roadside 7. Supermarkets 8. Homestead; 66. No sweetpotato was sold; 97-Other (Specify ) |

## Section III. Sweetpotato utilization in the household for food

| **1**. What are all the ways your household consumes sweetpotato?<br><br>[*Use: 1. Yes 0. No*] | | | | | | | **2**. Which variety of sweetpotato do you cook **most frequently** for your home consumption?<br><br>[*Use variety codes*] | 3. What is 2nd most frequently consumed variety in your home<br><br>[*use variety codes*]<br><br>99-N/A | 4. What is the 3rd most frequently consumed variety in your household?<br><br>[*use variety codes*]<br><br>99-N/A |
|---|---|---|---|---|---|---|---|---|---|
| **1a.** Boil it | 1b. Roast it | 1c. Fry it | 1d. **P**orridge | 1e. Futali | 1f. Fresh/raw | **1g.** Other (specify) | | | |
| | | | | | | | | | |

5. If your household consumes Orange Fleshed sweetpotato from sources other than own, where do you get it from?
*(1. Buy from market 2. Buy from other farmers 3. Free from other farmers, 4. Only got from Own Farm, 97. Other (specify…) 99. Not Applicable (do not consume) [Select all that apply]*

Variety code**:** *(1. Zondeni, 2. Anaakwanire, 3. Kaphulira, 4. Mathuthu, 5. Kadyaubwerere, 6. Chipika, 990. Other OFSP Variety, 7. Kenya (Vision, Admarc, 41, Boma, Research, Hybrid, Kasungu, Kenya mtuwa kuwalo, kenya yellow), 8. Babache, 9. Chikupha, 10. Chinese, 11. Folida, 12. Gwentha, 13. John, 14. Kachikhula, 15. Kamchiputu, 16. Kampalendo, 17. Kangazani, 18. Mugamba, 19. Namojoni, 20. Nsanje, 21. Nyamoyo, 22. Selera, 23. Semusa, 24. Bulenga, 25. CADECOM, 26. Catcom, 27. Chikhutu, 28. Chisilu, 29. Kaulesi, 30. Lifeboy, 31. Mangochi, 32. Sakananthaka, 991. Other (specify1))*

## PART D: EXPOSURE TO TRAINING AND ORANGE-FLESHED SWEETPOTATO INTERVENTIONS

Information from Part B: if orange-fleshed sweetpotato before 2017 received from CIP project or NGO/CIP-partner

| 1. Training type | 2. Training provided? 1.Yes 0.No | 3. Year training received **YYYY** | 4. How many days did you attend the training? | 5a. For Agricultural training: List if you were trained on the following components. [*tick box of* *1. Cultivation practices* *2. Sorting,* *3. Packaging* *4. Transportation capacity* *5. Mother-baby-trial* *6. Triple S (sand, storage, sprout)* *97. Other, (specify*) | 5b. On which Nutritional components were you trained? *1. Cooking Demonstrations* *2. Food Types* *3. Feeding Pregnant/Lactating Mothers* *4. Feeding children under 5years* *97. Other (Specify)* | 6a. Did your spouse also attend the training? 0. No 1. Yes | 6b. If 6a is YES: How many days did she/he attend? | 7. How many other household members attended? |
|---|---|---|---|---|---|---|---|---|
| Agricultural | | | | | | | | |
| Nutritional | | | | | | | | |

8. After 2017, how many agricultural trainings on sweetpotato /OFSP have you participated in?

9. After 2017, how many nutritional training sessions have you attended?

10a. Have you listened to any program on OFSP on the radio? 0. No 1. Yes _____

10b. If Yes, how many times did you hear it since January 2018? *(1. At least once every week 2. At least once every month 3. At least once every 3 months 4. At least once every 6 months 5. At least once a year (2018))*

10c. Did you like the OFSP program you heard over the radio. 0. No 1. Yes _____

11a. Have you received any flyers about the nutritious benefits of OFSP? 0. No 1. Yes

11b. How many times have you received the fliers since 2016? _____

11c. When was the last time you received a flyer? (YYYY)____

12. Have you seen/ participated in a drama/skit about OFSP? 0. No 1. Yes _____

13. Have you listened to any OFSP songs? *(0. No 1.Yes)*

14a. Have you participated in any cooking demonstration? 0. No 1. Yes _____

14b. If yes, mention the year(s)……

14c. Have you received any OFSP recipes (i.e. how to make different foods from OFSP)? 0. No 1. Yes ____

## PART E: HOUSEHOLD FOOD INSECURITY ACCESS SCALE (HFIAS)

[*Each of the questions in the following table is asked with a recall period of four weeks (30 days). The respondent is first asked whether the condition in the question happened at all in the past four weeks (yes or no). If the respondent answers "yes", then she/he is asked to determine whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten times) in the past four (4) weeks. Explain to the respondent our definitions of rarely, sometimes and often.*]

| | | Response<br><br>0. No 1. Yes | Frequency codes:<br><br>1. Rarely (1-2 times) 2. Sometimes (3-10 times) 3. Often (>10 times) during the past 4 weeks |
|---|---|---|---|
| 1 | In the past four weeks, did you worry that your household would not have enough food? | | |
| 2 | In the past four weeks, were you or any household member not able **to eat the kinds of foods you preferred** due to lack of resources? | | |
| 3 | In the past four weeks, did you or any household member have to eat **a limited variety** of foods due to lack of means to buy them?* | | |
| 4 | In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food? | | |
| 5 | In the past four weeks, did you or any household member have to eat a **smaller meal** than you felt you needed because there was not enough food? | | |
| 6 | In the past four weeks, did you or any other household member have to eat **fewer meals** in a day because there was not enough food? | | |
| 7 | In the past four weeks, was there **ever (a day when there was) no food** to eat of **any kind** in your household because of lack of resources to get food? | | |
| 8 | In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food? | | |
| 9 | In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food? | | |

| | | May | June | July | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | What months of the year do you consume sweetpotato in your meals at least twice a week? | | | | | | | | | | | | |
| 11 | In the last 12 months, which months did you have less than two meals a day from your own resources (purchases and production)? | | | | | | | | | | | | |
| 12 | In the last 12 months, which months did the household receive relief food or food from an external source? | | | | | | | | | | | | |

## PART F: HOUSEHOLD FOOD CONSUMPTION

### Section I: Food consumption frequency by household, reference woman and reference child in the past 24 hours

[*Note: The reference child as the youngest child between 6 months and 59 months (< 5 years) and the reference woman can be a pregnant /lactating mother/mother with child under 5 (in order of preference). If both women are present, choose pregnant woman. (Both of these women may have a child qualifying as reference child; if so, choose the youngest child between 6-59 months of the pregnant woman. If the pregnant woman does not have a child, choose youngest child in the household as reference child*)]

| Name reference woman: | Name reference child: |
|---|---|

***The Reference woman should be interviewed*.**

Now we would like to ask you questions about the type of foods anyone in your household ate yesterday during the day and during the night, then you yourself, and finally, those eaten by your child [NAME]. Yesterday, did your household (HH) consume at least a tablespoon (15gm minimum) per person of any of the following kinds of food? For example, if you had a soup made with carrots, potatoes and meat, you should reply "yes" for each of these ingredients when I read you the list.

[*First ask the question for woman's consumption for a category of food. Use 0. No 1. Yes*]

| | Codes A | Codes B | | | | Codes | Codes | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1=HH | 2=Ref woman | 3=Ref child | | | 1=HH | 2=Ref woman | 3=Ref child |
| **1** | Any foods made from grains (like maize, rice, wheat, sorghum, millet, noodles, bread) | | | | **11** | Any eggs | | | |
| **2** | Any biofortified crops (OFSP, orange maize, iron rich beans) | | | | **12** | Any fish or seafood, fresh or dried | | | |
| **3** | Any vegetables or roots that are orange-colored inside (OFSP, pumpkin, carrot) | | | | **13** | Any beans or peas (fresh or dried beans, soy bean, lentils) | | | |
| **4** | Any white roots and tubers or plantains/bananas (irish potatoes, yams, cassava, white-fleshed sweetpotato) | | | | **14** | Any nuts or seeds (groundnuts, whole or "butter", sunflower seeds) | | | |
| **5** | Any dark green leafy vegetables (sweetpotato leaves, cassava leaves, Rape, amaranth, pumpkin leaves masuku, gradanila, yellow peaches) | | | | **15** | Any milk or milk products (such as chees or yogurt, but NOT butter, or ice cream) | | | |
| **6** | Any fruits that are dark yellow or orange inside (ripe mango, ripe papaya, passion fruit) | | | | **16** | Any red palm oil or red palm nut pulp sauce | | | |
| **7** | Any other vegetables (like eggplant, okra, tomatoes), cucumber | | | | **17** | Any foods made with any other type of oil, fat, or butter | | | |
| **8** | Any other fruits (like avocado, pineapple), chipwete, guava, masau, malambe, bwemba, | | | | **18** | Any sweets and sugar (Like sugar, honey, sweetened | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | jambula, white peaches, straw berries, coconut) | | | | | soda, candies, cookies) | | | |
| **9** | Any meat made from animal organs (like liver, heart, kidney, blood-based foods) | | | | **19** | Any condiments or seasonings (used in small amounts for flavoring) | | | |
| **10** | Any other types of meat or poultry (like beef, pork, goat, mice, chicken, wild birds) | | | | **20** | Any other beverages and foods (tea, coffee, alcohol, olives, etc.) | | | |

| Question | Question (*instruction*) | Answer |
|---|---|---|
| **21** | Yesterday, how many times did the adults and older children (>14 years old) in this household eat orange-fleshed sweetpotato? (*enter # or 88=N/A)* | |
| **22** | Yesterday, how many times did the children from 5 years to 14 years old eat orange-fleshed sweetpotato? (*enter # or 88=N/A)* | |
| **23** | Yesterday, how many times did the reference child in this household eat orange-fleshed sweetpotato? (*enter # or 88=N/A)* | |
| **24** | If the reference child ate orange-fleshed sweetpotato yesterday, how much did it eat? | |
| **25a** | Number of very small roots (*If none: 0*) | |
| **25b** | Number of small roots (*If none: 0*) | |
| **25c** | Number of medium roots (*If none: 0*) | |
| **25d** | Number of large roots (*If none: 0*) | |

**Section II: Frequency of consumption of vitamin A rich foods – 7 day recall**

| | During the last **seven days**, on how many <u>days</u>, the child and you as a reference woman, ate any of the food items below (go one by one by the food items and one by one by the days.<br>[*Note :1. This is about the number of DAYS, NOT about the number of MEALS<br>2. This includes food consumed outside the household<br>3. This is about food items, which may be part of a dish, such as the child's porridge*] | **Ref Child** | **Reference woman** |
|---|---|---|---|
| | | **Number** | **Number** |
| **1** | Any foods made from grains (like maize, rice, teff, wheat, barley sorghum, millet, noodles, bread, injera | | |
| **2** | Whole chilies or peppers | | |
| **3** | Any dark green leafy vegetables (sweetpotato leaves, cassava leaves, pumpkin leaves, kale, etc.) | | |
| **4** | Pumpkin leaves | | |
| **5** | Sweetpotato leaves | | |
| **6** | Amaranth leaves | | |
| **7** | Red palm oil | | |
| **8** | Milk or milk products | | |
| **9** | Carrots | | |
| **10** | Ripe mango | | |
| **11** | Pumpkin or orange squash | | |
| **12** | Ripe papaya, fresh or as juice | | |
| **13** | Wheat/Biscuits/Cookies/Bread | | |
| **14** | White-fleshed sweetpotato | | |
| **15** | Orange-fleshed sweetpotato | | |
| **16** | Yellow-fleshed Sweetpotato | | |
| **17** | Eggs with Yolk | | |
| **18** | Any fish FRESH (with intact liver) | | |

| | | | |
|---|---|---|---|
| **19** | Liver - from any animal or bird (e.g. chicken) or fish | | |
| **20** | Meat from cow/pig/sheep/rabbit/rat or wild game | | |
| **21** | Butter | | |
| **22** | Cod liver oil | | |
| **23** | Food fried in oil or with oil | | |
| **24** | Passion fruit (or other fruit rich in vitamin A) | | |
| **25** | Vitamin A fortified margarine (e.g., PRESTIGE, BLUEBAND, etc) or oil | | |
| **26** | Chicken or other fowl | | |
| **27** | Weaning food fortified with vitamin A, like Cerelac | | |
| **28** | Infant formula (e.g. NAN, etc) fortified with vitamin A | | |
| **29** | Coconut milk or oil, cooking oil, ghee | | |
| **30** | Any sugar to which Vitamin A has been added | | |
| **31** | Lentils, Beans (all kinds), peas, other legumes | | |
| **32** | Groundnut, cashew nut or any other nut | | |
| **33** | Purple-fleshed sweetpotato, Avocado | | |
| **34** | **On a typical day in the last 7 days how many roots, if any, of orange-fleshed sweetpotato does the reference child eat?** | | |
| **35** | What was the average size of these roots: *(1. Very small, 2. Small, 3. Medium, 4. Large) [Show pictures]* | | |
| **36** | **On a typical day in the last 7 days how many roots, if any, of orange-fleshed sweetpotato does the reference woman eat?** | | |
| **37** | What was the average size of these roots: *(1. Very small, 2. Small, 3. Medium, 4. Large) [Show pictures]* | | |
| **38** | If either the Ref child or Ref women consumed orange-fleshed sweetpotato in the last 7 days, orange-fleshed sweetpotato was obtained from *(1. Your field, 2. Market, 3. Relative/neighbor, 4. Current project, 77. Do not know 97. Other (specify), 99. Not Applicable* | | |

## PART G. ACCESS TO EXTENTION, CREDIT AND GROUP MEMBERSHIP

**Section I. Access to extension services during the most recent season of 2018 or 2019**

1. Did any agricultural extension officer or lead farmer contact you about sweetpotato during the most recent season of 2018 or 2019? 0.No 1. Yes

2. If Yes, **c**omplete the table below:

| Code | Extension services | 2.1. Did you receive extension services on [ ] | 2.2. Number of contacts with extension officer/lead farmer for [ ] |
|---|---|---|---|
| | | 0. No 1. Yes | In Days |
| 1 | Sweetpotato varieties | | |
| 2 | Pest and disease control | | |
| 3 | Crop rotation | | |
| 4 | Vine conservation | | |
| 5 | Root storage | | |
| 6 | Collective action/farmer organization | | |
| 97 | Other (specify) | | |

| 3. Did you or any member of your household seek credit during the most recent season of 2018 or 2019? 0. No 1. Yes | 4. If Yes, did you get it? 0. No 1. Yes | 5. How much did you get? (MK) | 6. Source of credit **Codes A** | 7. What was the credit for? **Codes B** |
|---|---|---|---|---|
| | | | | |

| **Codes B:** | | **Codes A** | |
|---|---|---|---|
| *1. Buy vines* | *4. Pay/invest in transport* | *1. Money lender* | *4. Family member* |
| *2. Buy fertilizer or pesticides* | *5. Pay for labor* | *2. Farmer group/coop* | *5. Microfinance/bank* |
| *3. Buy farm equipment* | *97. Other (specify)* | *3. Neighbor* | *6. SACCO* |
| | | | *7. Village Banks and Loans (VSL)* |
| | | | *8. Table banking (Chipereganyo)* |
| | | | *9. NGO* |
| | | | *97. Other, (Specify)* |

**Section II. Membership in farmer organizations <u>in the last 5 years</u>** (i.e., since 2015) (One group membership per row.)

| 1. Has any member of your household been involved in any farmer organizations in the last 5 years? | | | | 0. No 1. Yes | |
|---|---|---|---|---|---|
| 2a. Member ID | 2b. If Yes name of household member | 3. Type of farmer organization the household member is/was involved in: **Codes A** (select all that apply) | 4. Two most important group functions: **Codes B** | 5. Year joined the group? (YYYY) | 6. Are you still a member of the farmer organization? 0. No 1. Yes |
| | | | | | |
| | | | | | |
| | | | | | |

| | | | |
|---|---|---|---|
| ***Codes A***<br>*1. Input supply/farmer cooperatives/union*<br>*2. Crop/seed producer and marketing group/coopsgroup/coopsgroup/cooperatives*<br>*3. Farmers' Association*<br>*4. Religious organization* | *5. Women's Association*<br>*6. Youth Association*<br>*7. NGO*<br>*8. Saving and credit group*<br>*9. Water User's Association*<br>*10. Men's Association (Chipereganyu)*<br>*97. Other (specify)* | ***Codes B***<br>*1. Produce marketing*<br>*2. Input access/marketing*<br>*3. Vine production*<br>*4. Farmer research group*<br>*5. Savings and credit*<br>*6. Training* | *7. Labor sharing*<br>*8. Tree planting and nurseries*<br>*9. Soil & water conservation*<br>*10. Input credit*<br>*11. access to information/technologies*<br>*12. Livestock marketing*<br>*13. Management of water distribution/use*<br>*14. Social welfare*<br>*15. Irrigation farming*<br>*97. Other (specify)* |

## PART H. OTHER SOURCES OF INCOME

**Which other sources of income have you had since January 2019**

| **1. Income Sources** | **2**. Earned from source? 0. No 1. Yes | **3.** Quantity | 4. (units) [*Use codes below table*] | **5.** Price/ unit | **6.** Total income (MK) | **7.** Who controls it? **1.** Male **0.** Female **2.** Both |
|---|---|---|---|---|---|---|
| **1.** Milk | | | | | | |
| **2.** Eggs | | | | | | |
| **3.** Manure/compost | | | | | | |
| **4.** Other livestock products (specify.....) | | | | | | |
| **5.** Rented out land | | | | | | |
| **6.** Other crops (besides sweetpotato roots) | | | | | | |
| **7.** Crop vines | | | | | | |
| **7b.** Crop residues | | | | | | |
| **8.** Rented out oxen | | | | | | |
| **9.** Regular employment income | | | | | | |
| **10.** Casual employment income | | | | | | |
| **11.** Own business (e.g., tailoring) | | | | | | |
| **12.** Pension income | | | | | | |
| **13.** Remittances | | | | | | |
| **14.** Marriage gifts (e.g., dowry) | | | | | | |
| **15.** Sale of trees/timber/firewood, etc. | | | | | | |
| **16.** Sale of charcoal, bricks, stones, sand, etc.) | | | | | | |
| **17.** Fishing/fisheries | | | | | | |
| **18.** Bee keeping (honey and other bee products) | | | | | | |
| **97**. Other (specify)_____ | | | | | | |

**Quantity Units: (*1*. *Liters* *2*. *Trays* *3*. *Wheelbarrow* *4*. *Pickups* *5*. *Pieces/count* *6*. *M-square* *7*. *Acres 8. Kilograms 9. 50kg bags* *97*. *Other (specify))***

## PART I: HOUSING CHARACTERISTICS AND FACILITIES ACCESS IN 2019

| CODE | QUESTIONS | | ANSWERS |
|---|---|---|---|
| 1 | Main walling material of main residential house | *Codes A* | |
| 2 | Main roofing material of main residential house | *Codes B* | |
| 3 | Main residential house has glass windows | *(0. No 1. Yes)* | |
| 4 | Household main source of lighting? | *Codes C* | |
| 5 | Household main source of energy for cooking? | *Codes D* | |
| 6 | Household main source of water for domestic water? | *Codes E* | |
| 7 | Distance to the main source of water for domestic use in walking time | *In minutes* | |
| 8 | Do you have a pit latrine | 0. No 1. Yes | |

| **Codes A:** | | **Codes B:** | **Codes C:** | **Codes D:** | **Codes E:** |
|---|---|---|---|---|---|
| 1. Burned bricks<br>2. Concrete blocks<br>3. Mud blocks<br>4. Stone | 5. Timber and grass<br>6. Wooden<br>7. Wattle<br>97. Other (specify) | 1. Iron sheet<br>2. Tiles<br>3. Grass thatched<br>4. Asbestos sheet (Mapale)<br>97. Other (specify) | 0. None<br>1.Public-electricity supply<br>2. Solar<br>3. Generator<br>4. Kerosene<br>5. Candles<br>6. Torch<br>7. Grass/ Firewood (Muuni)<br>8. Car/Motorcycle Batteries Rechargeable<br>9. Dry-cells/Batteries (non-rechargable) connected to bulbs<br>97. Other (specify) | 1. Fire wood<br>2. Charcoal<br>3. Bio-gas<br>4.LPG gas<br>5. Electricity<br>6. Crop Residues<br>97. Other (specify) | 1. Piped water<br>2. Borehole<br>3. Wells<br>4. Spring<br>5. Stream/River<br>6. Lake Pond/Dam/flood<br>8.Harvested rain water<br>97. Other (specify) |

## PART J: HOUSEHOLD AND LIVESTOCK ASSETS

### Section I: Production equipment

Which Agricultural/production equipment do you currently have in your household [list of equipment]

_____

| Codes | 1. Agricultural equipment | 2. Number owned | 3. If you were to buy EACH of the ASSET your household owns from someone else (e.g. a neighbour) in THEIR CURRENT CONDITION, how much (MK) in TOTAL would you pay? **(Value MK)** |
|---|---|---|---|
| 1 | Ox cart | | |
| 2 | Ox-plough | | |
| 3 | Hoe | | |
| 4 | Forked hoe | | |
| 5 | Panga knives | | |
| 6 | Pick axe | | |
| 7 | Shovel/Spade | | |
| 8 | Sickle | | |
| 9 | Treadle pump | | |
| 10 | Bow saw | | |
| 11 | Slashing/lawnmower | | |
| 12 | Sprayer | | |
| 13 | Axe | | |
| 14 | Pruning knife | | |
| 15 | Wheelbarrow | | |
| 16 | Tractor | | |
| 17 | Tractor trailer | | |
| 18 | Disc plough | | |
| 19 | Watering can | | |
| 20 | Watering pumps | | |
| 21 | Rake | | |
| 22 | Hand Fork/ hand hoe | | |
| 23 | Jerk | | |
| 97 | Other, (specify) | | |

### Section II: Livestock

Which livestock does your household currently have? [list of livestock] [*Use 1-Yes 0-No*] _____

| Codes | 1. Livestock | 2. Number owned | 3. If you were to buy EACH of the LIVESTOCK your household owns from someone else (e.g. a neighbor) in THEIR CURRENT STATUS, how much (MK) in TOTAL would you pay? **(Value in MK)** |
|---|---|---|---|
| 1 | Cows | | |
| 2 | Heifers (young) | | |
| 3 | Calves | | |
| 4 | Bulls | | |
| 5 | Donkeys | | |
| 6 | Goats | | |
| 7 | Sheep | | |
| 8 | Pigs | | |
| 9 | Rabbits | | |
| 10 | Chickens | | |
| 11 | Turkeys | | |
| 12 | Guinea Fowls | | |
| 13 | Pigeons | | |
| 14 | Quails | | |
| 15 | Ducks | | |
| 16 | Fish ponds | | |
| 17 | Bee hives | | |
| 97 | Other (specify) | | |

**Section III: Household belongings**

Which household belongings does your household currently have [list of durable goods] [*Use 1-Yes 0-No*]

_____

| Codes | 1. Durable Goods | 2. Number owned | 3. If we were to buy your […] in its current condition, how much would we pay for it? **(Value in MK)** |
|---|---|---|---|
| 1 | Bicycle | | |
| 2 | Motorcycle/Scooter | | |
| 3 | Automobile (vehicles) | | |
| 4 | Computer/laptop | | |
| 5 | Tablet | | |
| 6 | Living room furniture | | |
| 7 | Radio /Radio-cassette | | |
| 8 | Television set | | |
| 9 | DVD player | | |
| 10 | Regular mobile phone | | |
| 11 | Smart phone | | |
| 12 | Sewing machine | | |
| 13 | Solar panel | | |
| 97 | Other (specify) | | |

Thank you very much for your time!!!

Comments by Enumerator: ……**Time of Completion _____ [HH:MM]**

## **Supplementary Material B –** Ethics Clearance Letter

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**NATIONAL COMMITTEE ON RESEARCH ETHICS IN THE SOCIAL SCIENCES AND HUMANITIES**

**Ref No: NCST/RTT/2/6** **3rd August, 2020**

Dr Julius Okello
International Potato Centre
P.O. Box 22274
Kampala
Uganda

**E-mail**:j.okello@cgiar.org

Dear Dr J Okello,

**RESEARCH ETHICS AND REGULATORY APPROVAL OF PROTOCOL NO.P.08/19/407: ADOPTION AND IMPACT OF ORANGE-FLESHED SWEET POTATO VARIETIES IN MALAWI**

Having satisfied all the relevant ethical and regulatory requirements, I am pleased to inform you that the above referred research protocol has officially been approved. You are now permitted to proceed with its implementation. Should there be any amendments to the approved protocol in the course of implementing it, you shall be required to seek approval of such amendments before implementation of the same.

This approval is valid for one year from the date of issuance of this approval. If the study goes beyond one year, an annual approval for continuation shall be required to be sought from the National Committee on Research Ethics in the Social Sciences and Humanities (NCRSH) in a format that is available at the

**NCRSH Address:**
**Secretariat, National Committee on Research in the Social Sciences and Humanities, National Commission for Science and Technology, Lingadzi House, City Centre, P/Bag B303, Capital City, Lilongwe3, Malawi. Telephone Nos: +265 771 550/774 869; E-mail address: ncrsh@ncst.mw**

Secretariat. Once the study is finalised, you are required to furnish the Committee and the Commission with a final report of the study. The committee reserves the right to carry out compliance inspection of this approved protocol at any time as may be deemed by it. As such, you are expected to properly maintain all study documents including consent forms and data collection tools for a period not more than five years. Wishing you a successful implementation of your study.

Yours Sincerely,

Mike Kachedwa

HEAD OF NCRSH SECRETARIAT

**For: CHAIRMAN OF NCRSH**

**NCRSH Address:**
**Secretariat, National Committee on Research in the Social Sciences and Humanities, National Commission for Science and Technology, Lingadzi House, City Centre, P/Bag B303, Capital City, Lilongwe3, Malawi. Telephone Nos: +265 771 550/774 869; E-mail address: ncrsh@ncst.mw**


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